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Ada COMPILER  
VALIDATION SUMMARY REPORT:  
Certificate Number: 910809W1.11196  
Alsys, Inc.  
AlsyCOMP 058, version 5.3  
Unisys B39 under BTOS II, v3.2.0 =>  
Unisys B39 under BTOS II, v3.2.0

Prepared By:  
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| Other        |  |
| Remarks      |  |
| A-1          |  |

## Certificate Information

The following Ada implementation was tested and determined to pass ACVC 1.11. Testing was completed on 9 August 1991.

Compiler Name and Version: AlsyCOMP\_058, version 5.3

Host Computer System: Unisys B39 under BTOS II, v3.2.0


Target Computer System: Unisys B39 under BTOS II, v3.2.0

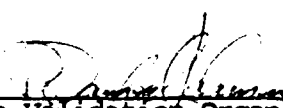
Customer Agreement Number: 91-04-22-ALS

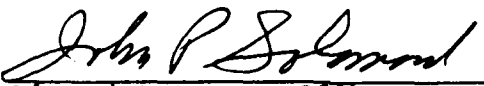
See section 3.1 for any additional information about the testing environment.

As a result of this validation effort, Validation Certificate 910809W1.11196 is awarded to Alsys, Inc. This certificate expires on 1 June 1993.

This report has been reviewed and is approved.

  
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## DECLARATION OF CONFORMANCE

**CUSTOMER;**  
**ADA VALIDATION FACILITY:** Alsys, Inc.  
Ada Validation Facility (ASD/SCEL)  
Computer Operations Division  
Information Systems and Technology Center  
Wright-Patterson AFB OH 45433-6503

**ACVC VERSION:** 1.11

### ADA IMPLEMENTATION:

**COMPILER NAME AND VERSION:** ALSYCOMP\_058, version 5.3

**HOST COMPUTER SYSTEM:** Unisys B39  
under BTOS II, v3.2.0

**TARGET COMPUTER SYSTEM:** Unisys B39  
under BTOS II, v3.2.0

### CUSTOMER'S DECLARATION

I, the undersigned, representing Alsys, Inc., declare that Alsys, Inc. has no knowledge of deliberate deviations from the Ada Language Standard ANSI/MIL-STD-1815A in the implementation listed in this declaration.

George Romanski

Date: 5 AUGUST 1991

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## CHAPTER 1

### INTRODUCTION

The Ada implementation described above was tested according to the Ada Validation Procedures [Pro90] against the Ada Standard [Ada83] using the current Ada Compiler Validation Capability (ACVC). This Validation Summary Report (VSR) gives an account of the testing of this Ada implementation. For any technical terms used in this report, the reader is referred to [Pro90]. A detailed description of the ACVC may be found in the current ACVC User's Guide [UG89].

#### 1.1 USE OF THIS VALIDATION SUMMARY REPORT

Consistent with the national laws of the originating country, the Ada Certification Body may make full and free public disclosure of this report. In the United States, this is provided in accordance with the "Freedom of Information Act" (5 U.S.C. #552). The results of this validation apply only to the computers, operating systems, and compiler versions identified in this report.

The organizations represented on the signature page of this report do not represent or warrant that all statements set forth in this report are accurate and complete, or that the subject implementation has no nonconformities to the Ada Standard other than those presented. Copies of this report are available to the public from the AVF which performed this validation or from:

National Technical Information Service  
5285 Port Royal Road  
Springfield VA 22161

Questions regarding this report or the validation test results should be directed to the AVF which performed this validation or to:

Ada Validation Organization  
Computer and Software Engineering Division  
Institute for Defense Analyses  
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## INTRODUCTION

### 1.2 REFERENCES

Reference Manual for the Ada Programming Language, [Ada83]  
ANSI/MIL-STD-1815A, February 1983 and ISO 8652-1987.

Ada Compiler Validation Procedures, Version 2.1, [Pro90]  
Ada Joint Program Office, August 1990.

Ada Compiler Validation Capability User's Guide, [UG89] 21 June 1989.

### 1.3 ACVC TEST CLASSES

Compliance of Ada implementations is tested by means of the ACVC. The ACVC contains a collection of test programs structured into six test classes: A, B, C, D, E, and L. The first letter of a test name identifies the class to which it belongs. Class A, C, D, and E tests are executable. Class B and class L tests are expected to produce errors at compile time and link time, respectively.

The executable tests are written in a self-checking manner and produce a PASSED, FAILED, or NOT APPLICABLE message indicating the result when they are executed. Three Ada library units, the packages REPORT and SPPRTL3, and the procedure CHECK FILE are used for this purpose. The package REPORT also provides a set of Identity functions used to defeat some compiler optimizations allowed by the Ada Standard that would circumvent a test objective. The package SPPRTL3 is used by many tests for Chapter 13 of the Ada Standard. The procedure CHECK FILE is used to check the contents of text files written by some of the Class C tests for Chapter 14 of the Ada Standard. The operation of REPORT and CHECK FILE is checked by a set of executable tests. If these units are not operating correctly, validation testing is discontinued.

Class B tests check that a compiler detects illegal language usage. Class B tests are not executable. Each test in this class is compiled and the resulting compilation listing is examined to verify that all violations of the Ada Standard are detected. Some of the class B tests contain legal Ada code which must not be flagged illegal by the compiler. This behavior is also verified.

Class L tests check that an Ada implementation correctly detects violation of the Ada Standard involving multiple, separately compiled units. Errors are expected at link time, and execution is attempted.

In some tests of the ACVC, certain macro strings have to be replaced by implementation-specific values — for example, the largest integer. A list of the values used for this implementation is provided in Appendix A. In addition to these anticipated test modifications, additional changes may be required to remove unforeseen conflicts between the tests and implementation-dependent characteristics. The modifications required for this implementation are described in section 2.3.

## INTRODUCTION

For each Ada implementation, a customized test suite is produced by the AVF. This customization consists of making the modifications described in the preceding paragraph, removing withdrawn tests (see section 2.1), and possibly removing some inapplicable tests (see section 2.2 and [UG89]).

In order to pass an ACVC an Ada implementation must process each test of the customized test suite according to the Ada Standard.

### 1.4 DEFINITION OF TERMS

|                                           |                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                 |
|-------------------------------------------|-------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|
| Ada Compiler                              | The software and any needed hardware that have to be added to a given host and target computer system to allow transformation of Ada programs into executable form and execution thereof.                                                                                                                                                                                                                                                                                                                                                       |
| Ada Compiler Validation Capability (ACVC) | The means for testing compliance of Ada implementations, consisting of the test suite, the support programs, the ACVC user's guide and the template for the validation summary report.                                                                                                                                                                                                                                                                                                                                                          |
| Ada Implementation                        | An Ada compiler with its host computer system and its target computer system.                                                                                                                                                                                                                                                                                                                                                                                                                                                                   |
| Ada Joint Program Office (AJPO)           | The part of the certification body which provides policy and guidance for the Ada certification system.                                                                                                                                                                                                                                                                                                                                                                                                                                         |
| Ada Validation Facility (AVF)             | The part of the certification body which carries out the procedures required to establish the compliance of an Ada implementation.                                                                                                                                                                                                                                                                                                                                                                                                              |
| Ada Validation Organization (AVO)         | The part of the certification body that provides technical guidance for operations of the Ada certification system.                                                                                                                                                                                                                                                                                                                                                                                                                             |
| Compliance of an Ada Implementation       | The ability of the implementation to pass an ACVC version.                                                                                                                                                                                                                                                                                                                                                                                                                                                                                      |
| Computer System                           | A functional unit, consisting of one or more computers and associated software, that uses common storage for all or part of a program and also for all or part of the data necessary for the execution of the program; executes user-written or user-designated programs; performs user-designated data manipulation, including arithmetic operations and logic operations; and that can execute programs that modify themselves during execution. A computer system may be a stand-alone unit or may consist of several inter-connected units. |



## INTRODUCTION

|                              |                                                                                                                                                                                                                                                                                       |
|------------------------------|---------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|
| Conformity                   | Fulfillment by a product, process, or service of all requirements specified.                                                                                                                                                                                                          |
| Customer                     | An individual or corporate entity who enters into an agreement with an AVF which specifies the terms and conditions for AVF services (of any kind) to be performed.                                                                                                                   |
| Declaration of Conformance   | A formal statement from a customer assuring that conformity is realized or attainable on the Ada implementation for which validation status is realized.                                                                                                                              |
| Host Computer System         | A computer system where Ada source programs are transformed into executable form.                                                                                                                                                                                                     |
| Inapplicable test            | A test that contains one or more test objectives found to be irrelevant for the given Ada implementation.                                                                                                                                                                             |
| ISO                          | International Organization for Standardization.                                                                                                                                                                                                                                       |
| LRM                          | The Ada standard, or Language Reference Manual, published as ANSI/MIL-STD-1815A-1983 and ISO 8652-1987. Citations from the LRM take the form "<section>.<subsection>:<paragraph>."                                                                                                    |
| Operating System             | Software that controls the execution of programs and that provides services such as resource allocation, scheduling, input/output control, and data management. Usually, operating systems are predominantly software, but partial or complete hardware implementations are possible. |
| Target Computer System       | A computer system where the executable form of Ada programs are executed.                                                                                                                                                                                                             |
| Validated Ada Compiler       | The compiler of a validated Ada implementation.                                                                                                                                                                                                                                       |
| Validated Ada Implementation | An Ada implementation that has been validated successfully either by AVF testing or by registration [Pro90].                                                                                                                                                                          |
| Validation                   | The process of checking the conformity of an Ada compiler to the Ada programming language and of issuing a certificate for this implementation.                                                                                                                                       |
| Withdrawn test               | A test found to be incorrect and not used in conformity testing. A test may be incorrect because it has an invalid test objective, fails to meet its test objective, or contains erroneous or illegal use of the Ada programming language.                                            |

## CHAPTER 2

### IMPLEMENTATION DEPENDENCIES

#### 2.1 WITHDRAWN TESTS

The following tests have been withdrawn by the AVO. The rationale for withdrawing each test is available from either the AVO or the AVF. The publication date for this list of withdrawn tests is 2 August 1991.

|         |         |         |         |         |         |
|---------|---------|---------|---------|---------|---------|
| E28005C | B28006C | C32203A | C34006D | C35508I | C35508J |
| C35508M | C35508N | C35702A | C35702B | B41308B | C43004A |
| C45114A | C45346A | C45612A | C45612B | C45612C | C45651A |
| C46022A | B49008A | B49008B | A74006A | C74308A | B83022B |
| B83022H | B83025B | B83025D | C83026A | B83026B | C83041A |
| B85001L | C86001F | C94021A | C97116A | C98003B | BA2011A |
| CB7001A | CB7001B | CB7004A | CC1223A | BC1226A | CC1226B |
| BC3009B | BD1B02B | BD1B06A | AD1B08A | BD2A02A | CD2A21E |
| CD2A23E | CD2A32A | CD2A41A | CD2A41E | CD2A87A | CD2B15C |
| BD3006A | BD4008A | CD4022A | CD4022D | CD4024B | CD4024C |
| CD4024D | CD4031A | CD4051D | CD5111A | CD7004C | ED7005D |
| CD7005E | AD7006A | CD7006E | AD7201A | AD7201E | CD7204B |
| AD7206A | BD8002A | BD8004C | CD9005A | CD9005B | CDA201E |
| CE2107I | CE2117A | CE2117B | CE2119B | CE2205B | CE2405A |
| CE3111C | CE3116A | CE3118A | CE3411B | CE3412B | CE3607B |
| CE3607C | CE3607D | CE3812A | CE3814A | CE3902B |         |

#### 2.2 INAPPLICABLE TESTS

A test is inapplicable if it contains test objectives which are irrelevant for a given Ada implementation. Reasons for a test's inapplicability may be supported by documents issued by the ISO and the AJPO known as Ada Commentaries and commonly referenced in the format AI-ddddd. For this implementation, the following tests were determined to be inapplicable for the reasons indicated; references to Ada Commentaries are included as appropriate.

## IMPLEMENTATION DEPENDENCIES

The following 201 tests have floating-point type declarations requiring more digits than `SYSTEM.MAX_DIGITS`:

|                       |                       |
|-----------------------|-----------------------|
| C24113L..Y (14 tests) | C35705L..Y (14 tests) |
| C35706L..Y (14 tests) | C35707L..Y (14 tests) |
| C35708L..Y (14 tests) | C35802L..Z (15 tests) |
| C45241L..Y (14 tests) | C45321L..Y (14 tests) |
| C45421L..Y (14 tests) | C45521L..Z (15 tests) |
| C45524L..Z (15 tests) | C45621L..Z (15 tests) |
| C45641L..Y (14 tests) | C46012L..Z (15 tests) |

C35404D, C45231D, B86001X, C86006E, and CD7101G check for a predefined integer type with a name other than `INTEGER`, `LONG_INTEGER`, or `SHORT_INTEGER`; for this implementation, there is no such type.

C35713D and B86001Z check for a predefined floating-point type with a name other than `FLOAT`, `LONG_FLOAT`, or `SHORT_FLOAT`; for this implementation, there is no such type.

C45531M..P and C45532M..P (8 tests) check fixed-point operations for types that require a `SYSTEM.MAX_MANTISSA` of 47 or greater; for this implementation, `MAX_MANTISSA` is less than 47.

C45536A, C46013B, C46031B, C46033B, and C46034B contain length clauses that specify values for `'SMALL` that are not powers of two or ten; this implementation does not support such values for `'SMALL`.

C45624A..B (2 tests) check that the proper exception is raised if `MACHINE_OVERFLOW` is `FALSE` for floating point types and the results of various floating-point operations lie outside the range of the base type; for this implementation, `MACHINE_OVERFLOW` is `TRUE`.

B86001Y uses the name of a predefined fixed-point type other than type `DURATION`; for this implementation, there is no such type.

C96005B uses values of type `DURATION`'s base type that are outside the range of type `DURATION`; for this implementation, the ranges are the same.

CD1009C checks whether a length clause can specify a non-default size for a floating-point type; this implementation does not support such sizes.

CD2A53A checks operations of a fixed-point type for which a length clause specifies a power-of-ten `TYPE'SMALL`; this implementation does not support decimal `'SMALLs`. (See section 2.3.)

CD2A84A, CD2A84E, CD2A84I..J (2 tests), and CD2A84O use length clauses to specify non-default sizes for access types; this implementation does not support such sizes.

# IMPLEMENTATION DEPENDENCIES

BD8001A, BD8003A, BD8004A..B (2 tests), and AD8011A use machine code insertions; this implementation provides no package MACHINE\_CODE.

The following 16 tests check operations on sequential, direct, and text files when multiple internal files are associated with the same external file and one or more are open for writing; USE\_ERROR is raised when this association is attempted.

|            |            |         |            |         |
|------------|------------|---------|------------|---------|
| CE2107B..E | CE2107G..H | CE2107L | CD2110B    | CE2110D |
| CE2111D    | CE2111H    | CE3111B | CE3111D..E | CE3114B |
| CE3115A    |            |         |            |         |

CE2111C checks whether a sequential file can be reset from mode IN\_FILE to mode OUT\_FILE; this implementation does not support this operation and raises USE\_ERROR.

CE2401H, EE2401D, and EE2401G use instantiations of DIRECT\_IO with unconstrained array and record types; this implementation raises USE\_ERROR on the attempt to create a file of such types.

The tests listed in the following table check that USE\_ERROR is raised if the given file operations are not supported for the given combination of mode and access method; this implementation supports these operations.

| Test    | File Operation | Mode       | File Access Method |
|---------|----------------|------------|--------------------|
| CE2102E | CREATE         | OUT FILE   | SEQUENTIAL_IO      |
| CE2102F | CREATE         | INOUT FILE | DIRECT_IO          |
| CE2102J | CREATE         | OUT FILE   | DIRECT_IO          |
| CE2102N | OPEN           | IN FILE    | SEQUENTIAL_IO      |
| CE2102O | RESET          | IN FILE    | SEQUENTIAL_IO      |
| CE2102P | OPEN           | OUT FILE   | SEQUENTIAL_IO      |
| CE2102Q | RESET          | OUT FILE   | SEQUENTIAL_IO      |
| CE2102R | OPEN           | INOUT FILE | DIRECT_IO          |
| CE2102S | RESET          | INOUT FILE | DIRECT_IO          |
| CE2102T | OPEN           | IN FILE    | DIRECT_IO          |
| CE2102U | RESET          | IN FILE    | DIRECT_IO          |
| CE2102V | OPEN           | OUT FILE   | DIRECT_IO          |
| CE2102W | RESET          | OUT FILE   | DIRECT_IO          |
| CE3102F | RESET          | Any Mode   | TEXT_IO            |
| CE3102G | DELETE         |            | TEXT_IO            |
| CE3102I | CREATE         | OUT FILE   | TEXT_IO            |
| CE3102J | OPEN           | IN FILE    | TEXT_IO            |
| CE3102K | OPEN           | OUT FILE   | TEXT_IO            |

The tests listed in the following table check the given file operations for the given combination of mode and access method; this implementation does not support these operations.

## IMPLEMENTATION DEPENDENCIES

| Test    | File Operation | Mode    | File Access Method |
|---------|----------------|---------|--------------------|
| CE2105A | CREATE         | IN_FILE | SEQUENTIAL_IO      |
| CE2105B | CREATE         | IN_FILE | DIRECT_IO          |
| CE3109A | CREATE         | IN_FILE | TEXT_IO            |

CE2203A checks that WRITE raises USE\_ERROR if the capacity of an external sequential file is exceeded; this implementation cannot restrict file capacity.

CE2403A checks that WRITE raises USE\_ERROR if the capacity of an external direct file is exceeded; this implementation cannot restrict file capacity.

CE3304A checks that SET\_LINE\_LENGTH and SET\_PAGE\_LENGTH raise USE\_ERROR if they specify an inappropriate value for the external file; there are no inappropriate values for this implementation.

CE3413B checks that PAGE raises LAYOUT\_ERROR when the value of the page number exceeds COUNT'LAST; for this implementation, the value of COUNT'LAST is greater than 150000, making the checking of this objective impractical.

CE3202A expects that function NAME can be applied to the standard input and output files; in this implementation these files have no names, and USE\_ERROR is raised. (See section 2.3.)

## 2.3 TEST MODIFICATIONS

Modifications (see section 1.3) were required for 20 tests.

The following tests were split into two or more tests because this implementation did not report the violations of the Ada Standard in the way expected by the original tests.

|         |         |         |         |         |         |
|---------|---------|---------|---------|---------|---------|
| B23004A | B24007A | B24009A | B28003A | B32202A | B32202B |
| B32202C | B37004A | B61012A | B91004A | B95069A | B95069B |
| B97103E | BA1101B | BC2001D | BC3009C |         |         |

BA2001E was graded passed by Evaluation Modification as directed by the AVO. The test expects that duplicate names of subunits with a common ancestor will be detected as compilation errors; this implementation detects the errors at link time, and the AVO ruled that this behavior is acceptable.

EA3004D was graded passed by Evaluation and Processing Modification as directed by the AVO. The test requires that either pragma INLINE is obeyed for a function call in each of three contexts and that thus three library units are made obsolete by the re-compilation of the inlined

## IMPLEMENTATION DEPENDENCIES

function's body, or else the pragma is ignored completely. This implementation obeys the pragma except when the call is within the package specification. When the test's files are processed in the given order, only two units are made obsolete; thus, the expected error at line 27 of file EA3004D6M is not valid and is not flagged. To confirm that indeed the pragma is not obeyed in this one case, the test was also processed with the files re-ordered so that the re-compilation follows only the package declaration (and thus the other library units will not be made obsolete, as they are compiled later); a "NOT APPLICABLE" result was produced, as expected. The revised order of files was 0-1-4-5-2-3-6.

When run as is, the implementation fails to detect an error on line 27 of test file EA3004D6M. This is because the pragma `INLINE` has no effect when its object is within a package specification. However, the results of running the test as-is do not confirm that the pragma had no effect, only that the package was not made obsolete. By re-ordering the compilations so that the two subprograms are compiled after file D5 (the re-compilation of the "with"ed package that makes the various earlier units obsolete), we create a test that shows that indeed pragma `INLINE` has no effect when applied to a subprogram that is called within a package specification. The test must execute and produce the expected NOT APPLICABLE result (as though `INLINE` were not supported at all). The recommended re-ordering of EA3004D test files is: 0-1-4-5-2-3-6.

CD2A53A was graded inapplicable by Evaluation Modification as directed by the AVO. The test contains a specification of a power-of-10 value as 'SMALL for a fixed-point type. The AVO ruled that, under ACVC 1.11, support of decimal 'SMALLs may be omitted.

CE3202A was graded inapplicable by Evaluation Modification as directed by the AVO. This test applies function `NAME` to the standard input file, which in this implementation has no name; `USE_ERROR` is raised but not handled, so the test is aborted. The AVO ruled that this behavior is acceptable pending any resolution of the issue by the ARG.

## CHAPTER 3

### PROCESSING INFORMATION

#### 3.1 TESTING ENVIRONMENT

The Ada implementation tested in this validation effort is described adequately by the information given in the initial pages of this report. For technical and sales information about this Ada implementation, contact:

George Romanski, Vice-President, Engineering  
Alsys, Inc.  
67 South Bedford Street  
Burlington, MA 01803-5152  
(617) 270-0030

Testing of this Ada implementation was conducted at the customer's site by a validation team from the AVF.

#### 3.2 SUMMARY OF TEST RESULTS

An Ada Implementation passes a given ACVC version if it processes each test of the customized test suite in accordance with the Ada Programming Language Standard, whether the test is applicable or inapplicable; otherwise, the Ada Implementation fails the ACVC [Pro90].

For all processed tests (inapplicable and applicable), a result was obtained that conforms to the Ada Programming Language Standard.

## PROCESSING INFORMATION

The list of items below gives the number of ACVC tests in various categories. All tests were processed, except those that were withdrawn because of test errors (item b; see section 2.1), those that require a floating-point precision that exceeds the implementation's maximum precision (item e; see section 2.2), and those that depend on the support of a file system — if none is supported (item d). All tests passed, except those that are listed in sections 2.1 and 2.2 (counted in items b and f, below).

|                                                    |      |
|----------------------------------------------------|------|
| a) Total Number of Applicable Tests                | 3792 |
| b) Total Number of Withdrawn Tests                 | 95   |
| c) Processed Inapplicable Tests                    | 82   |
| d) Non-Processed I/O Tests                         | 0    |
| e) Non-Processed Floating-Point<br>Precision Tests | 201  |
| f) Total Number of Inapplicable Tests              | 283  |
| g) Total Number of Tests for ACVC 1.11             | 4170 |

### 3.3 TEST EXECUTION

A magnetic tape containing the customized test suite (see section 1.3) was taken on-site by the validation team for processing. The contents of the magnetic tape were loaded directly onto a VAX system (from a standard 1/2 inch, 9-track VMS BACKUP tape) and then transferred to the Unisys B39 via ethernet.

After the test files were loaded onto the host computer, the full set of tests was processed by the Ada implementation.

The tests were compiled, linked, and executed on the host computer system, as appropriate. The results were captured on the computer system.

Testing was performed using command scripts provided by the customer and reviewed by the validation team. See Appendix B for a complete listing of the processing options for this implementation. It also indicates the default options. The options invoked explicitly for validation testing during this test were:

#### Compiler Options:

|             |                                                                      |
|-------------|----------------------------------------------------------------------|
| TEXT => NO  | Do not show source code in listing<br>(used for all but the B tests) |
| TEXT => YES | Show source code in listing<br>(used for the B tests)                |



## PROCESSING INFORMATION

|                   |                                                                                                                    |
|-------------------|--------------------------------------------------------------------------------------------------------------------|
| SHOW => NO        | Do not show header nor error summary in listing.                                                                   |
| WARNING => NO     | Do not include warning messages.                                                                                   |
| ERRORS => 999     | Maximum number of compilation errors permitted before terminating the compilation.                                 |
| CALLS => INLINED  | This option allows insertion of code for subprograms inline and must be set for the pragma INLINE to be operative. |
| GENERICCS => STUB | This option places code of generic instantiations in separate subunits.                                            |

The default options were used for all binds.

Test output, compiler and linker listings, and job logs were captured on magnetic tape and archived at the AVF. The listings examined on-site by the validation team were also archived.

# APPENDIX A MACRO PARAMETERS

This appendix contains the macro parameters used for customizing the ACVC. The meaning and purpose of these parameters are explained in [UG89]. The parameter values are presented in two tables. The first table lists the values that are defined in terms of the maximum input-line length, which is the value for \$MAX\_IN\_LEN—also listed here. These values are expressed here as Ada string aggregates, where "V" represents the maximum input-line length.

| Macro Parameter              | Macro Value                             |
|------------------------------|-----------------------------------------|
| \$MAX_IN_LEN                 | 255                                     |
| \$BIG_ID1                    | (1..254 => 'A', 255 => '1')             |
| \$BIG_ID2                    | (1..254 => 'A', 255 => '2')             |
| \$BIG_ID3                    | (1..127 => 'A') & '3' & (1..127 => 'A') |
| \$BIG_ID4                    | (1..127 => 'A') & '4' & (1..127 => 'A') |
| \$BIG_INT_LIT                | (1..252 => '0') & "298"                 |
| \$BIG_REAL_LIT               | (1..250 => '0') & "690.0"               |
| \$BIG_STRING1                | "" & (1..127 => 'A') & ""               |
| \$BIG_STRING2                | "" & (1..127 => 'A') & '1' & ""         |
| \$BLANKS                     | (1..235 => ' ')                         |
| \$MAX_LEN_INT_BASED_LITERAL  | "2:" & (1..250 => '0') & "11:"          |
| \$MAX_LEN_REAL_BASED_LITERAL | "16:" & (1..248 => '0') & "F.E:"        |
| \$MAX_STRING_LITERAL         | "" & (1..253 => 'A') & ""               |

## MACRO PARAMETERS

The following table lists all of the other macro parameters and their respective values.

| Macro Parameter                   | Macro Value                     |
|-----------------------------------|---------------------------------|
| \$ACC_SIZE                        | 32                              |
| \$ALIGNMENT                       | 2                               |
| \$COUNT_LAST                      | 2147483647                      |
| \$DEFAULT_MEM_SIZE                | 2**24                           |
| \$DEFAULT_STOR_UNIT               | 8                               |
| \$DEFAULT_SYS_NAME                | I80X86                          |
| \$DELTA_DOC                       | 2#1.0#E-31                      |
| \$ENTRY_ADDRESS                   | FCNDECL.ENTRY_ADDRESS           |
| \$ENTRY_ADDRESS1                  | FCNDECL.ENTRY_ADDRESS1          |
| \$ENTRY_ADDRESS2                  | FCNDECL.ENTRY_ADDRESS2          |
| \$FIELD_LAST                      | 255                             |
| \$FILE_TERMINATOR                 | ' '                             |
| \$FIXED_NAME                      | NO_SUCH_FIXED_TYPE              |
| \$FLOAT_NAME                      | NO_SUCH_FLOAT_TYPE              |
| \$FORM_STRING                     | ""                              |
| \$FORM_STRING2                    | "CANNOT_RESTRICT_FILE_CAPACITY" |
| \$GREATER_THAN_DURATION           | 75_000.0                        |
| \$GREATER_THAN_DURATION BASE LAST | 131_073.0                       |
| \$GREATER_THAN_FLOAT BASE LAST    | 1.0E+39                         |
| \$GREATER_THAN_FLOAT_SAFE LARGE   | 1.0E+38                         |

# MACRO PARAMETERS

\$GREATER\_THAN\_SHORT\_FLOAT\_SAFE\_LARGE  
     1.0E+38  
  
 \$HIGH\_PRIORITY       10  
  
 \$ILLEGAL\_EXTERNAL\_FILE\_NAME1  
     [SYS]<NODIRECTORY>FILENAME  
  
 \$ILLEGAL\_EXTERNAL\_FILE\_NAME2  
     THIS-FILE-NAME-IS-NOW-MUCH-TOO-  
     LONG-FOR-A-NAME-ON-MY-SYSTEM  
  
 \$INAPPROPRIATE\_LINE\_LENGTH  
     -1  
  
 \$INAPPROPRIATE\_PAGE\_LENGTH  
     -1  
  
 \$INCLUDE\_PRAGMA1       PRAGMA INCLUDE ("A28006D1.TST")  
 \$INCLUDE\_PRAGMA2       PRAGMA INCLUDE ("B28006D1.TST")  
  
 \$INTEGER\_FIRST        -32768  
  
 \$INTEGER\_LAST         32767  
  
 \$INTEGER\_LAST\_PLUS\_1   32768  
  
 \$INTERFACE\_LANGUAGE    ADA  
  
 \$LESS\_THAN\_DURATION   -75\_000.0  
  
 \$LESS\_THAN\_DURATION\_BASE\_FIRST  
     -131\_073.0  
  
 \$LINE\_TERMINATOR       ASCII.CR & ASCII.LF  
  
 \$LOW\_PRIORITY         1  
  
 \$MACHINE\_CODE\_STATEMENT  
     NULL;  
  
 \$MACHINE\_CODE\_TYPE     NO\_SUCH\_TYPE  
  
 \$MANTISSA\_DOC         31  
  
 \$MAX\_DIGITS           15  
  
 \$MAX\_INT              2147483647  
  
 \$MAX\_INT\_PLUS\_1       2\_147\_483\_648  
  
 \$MIN\_INT              -2147483648

## MACRO PARAMETERS

|                       |                                                            |
|-----------------------|------------------------------------------------------------|
| \$NAME                | NO_SUCH_TYPE_AVAILABLE                                     |
| \$NAME_LIST           | S370,I80X86,I80386,MC680X0,VAX,<br>TRANSPUTER,RS_6000,MIPS |
| \$NAME_SPECIFICATION1 | [SYS]<CE>X2120A                                            |
| \$NAME_SPECIFICATION2 | [SYS]<CE>X2120B                                            |
| \$NAME_SPECIFICATION3 | [SYS]<CE>X3119A                                            |
| \$NEG_BASED_INT       | 16#F000000E#                                               |
| \$NEW_MEM_SIZE        | 2**24                                                      |
| \$NEW_STOR_UNIT       | 16                                                         |
| \$NEW_SYS_NAME        | I80X86                                                     |
| \$PAGE_TERMINATOR     | ASCII.CR & ASCII.LF & ASCII.FF                             |
| \$RECORD_DEFINITION   | NEW_INTEGER                                                |
| \$RECORD_NAME         | NO_SUCH_MACHINE_CODE_TYPE                                  |
| \$TASK_SIZE           | 32                                                         |
| \$TASK_STORAGE_SIZE   | 1024                                                       |
| \$TICK                | 0.1                                                        |
| \$VARIABLE_ADDRESS    | FCNDECL.VARIABLE_ADDRESS                                   |
| \$VARIABLE_ADDRESS1   | FCNDECL.VARIABLE_ADDRESS1                                  |
| \$VARIABLE_ADDRESS2   | FCNDECL.VARIABLE_ADDRESS2                                  |
| \$YOUR_PRAGMA         | INTERFACE                                                  |

## APPENDIX B

### COMPILATION SYSTEM OPTIONS

The compiler options of this Ada implementation, as described in this Appendix, are provided by the customer. Unless specifically noted otherwise, references in this appendix are to compiler documentation and not to this report.

#### Compiler Options:

```

COMPILE (SOURCE      => source_name | INSTANTIATION,
         LIBRARY      => library_name,
         OPTIONS      =>
             (ANNOTATE  => character_string,
              ERRORS     => positive_integer,
              LEVEL      => PARSE | SEMANTIC | CODE | UPDATE,
              CHECKS     => ALL | STACK | NONE,
              GENERICS   => STUBS | INLINE,
              TASKING    => YES | NO,
              MEMORY     => number_of_kbytes),
         DISPLAY      =>
             (OUTPUT    => SCREEN | NONE | AUTOMATIC | file_name,
              WARNING    => YES | NO,
              TEXT       => YES | NO,
              SHOW       => BANNER | RECAP | ALL | NONE,
              DETAIL     => YES | NO,
              ASSEMBLY   => CODE | MAP | ALL | NONE),
         ALLOCATION    =>
             (STACK     => positive_integer,
              GLOBAL     => positive_integer),
         IMPROVE      =>
             (CALLS     => NORMAL | INLINED,
              REDUCTION  => NONE | PARTIAL | EXTENSIVE,
              EXPRESSIONS => NONE | PARTIAL | EXTENSIVE),
         KEEP         =>
             (COPY      => YES | NO,
              DEBUG     => YES | NO,
              TREE      => YES | NO));

```

# COMPILATION SYSTEM OPTIONS

| OPTION/SWITCH |                                          | EFFECT                                                  |
|---------------|------------------------------------------|---------------------------------------------------------|
| SOURCE        | => source_name   INSTANTIATION           | Name of source file.                                    |
| LIBRARY       | => library_name                          | Name of program library.                                |
| ANNOTATE      | => character_string                      | Comment string for library addition.                    |
| ERRORS        | => positive_integer                      | Abort compilation after count of errors.                |
| LEVEL         | => PARSE   SEMANTIC   CODE   UPDATE      | Specify level of compilation.                           |
| CHECKS        | => ALL   STACK   NONE                    | Specify which compilation checks to be done.            |
| GENERIC       | => STUBS   INLINE                        | Specifies where expansion of generic instantiation are. |
| TASKING       | => YES   NO                              | Skip Optimization for tasking?                          |
| MEMORY        | => number_of_kbytes                      | Sizes internal compiler work area.                      |
| OUTPUT        | => SCREEN   NONE   AUTOMATIC   file_name | Directs the output                                      |
| WARNING       | => YES   NO                              | Generate warning messages?                              |
| TEXT          | => YES   NO                              | Include full source text in listing?                    |
| SHOW          | => BANNER   RECAP   ALL   NONE           | Specify banner and error summary display.               |
| DETAIL        | => YES   NO                              | Generate detailed diagnostics?                          |
| ASSEMBLY      | => CODE   MAP   ALL   NONE               | Controls listings of generated code and data layout.    |
| STACK         | => positive_integer                      | Controls run-time location of stack data.               |
| GLOBAL        | => positive_integer                      | Controls runtime location of global data.               |
| CALLS         | => NORMAL   INLINED                      | Activates pragma inline.                                |
| REDUCTION     | => NONE   PARTIAL   EXTENSIVE            | Controls high level optimizer.                          |
| EXPRESSIONS   | => NONE   PARTIAL   EXTENSIVE            | Controls low level optimizer.                           |
| COPY          | => YES   NO                              | Copy source text to library?                            |
| DEBUG         | => YES   NO                              | Save debug info in library?                             |
| TREE          | => YES   NO                              | Save intermediate program representation?               |

# LINKER OPTIONS

The linker options of this Ada implementation, as described in this Appendix, are provided by the customer. Unless specifically noted otherwise, references in this appendix are to linker documentation and not to this report.

## Binder Options:

```

BIND (PROGRAM    => main_program_name,
      LIBRARY    => library_name,
      OPTIONS    =>
        (LEVEL      => CHECK | BIND | LINK,
         EXECUTION  => AUTOMATIC | DYNAMIC | PROTECTED,
         OBJECT     => AUTOMATIC | file_name,
         UNCALLED   => REMOVE | KEEP,
         TIMER      => NORMAL | FAST,
         SLICE      => NO | positive_integer),
      STACK      =>
        (MAIN       => positive_integer,
         TASK       => positive_integer,
         HISTORY    => YES | NO),
      HEAP       =>
        (SIZE       => positive_integer,
         INCREMENT  => positive_integer),
      INTERFACE  =>
        (DIRECTIVES => options_for_linker,
         MODULES    => file_names,
         SEARCH     => library_names),
      DISPLAY    =>
        (OUTPUT     => SCREEN | NONE | AUTOMATIC | file_name,
         DATA      => BIND | LINK | ALL | NONE,
         WARNING    => YES | NO),
      KEEP       =>
        (DEBUG      => YES | NO));

```



# COMPILATION SYSTEM OPTIONS

| OPTION/SWITCH                                   | EFFECT                                            |
|-------------------------------------------------|---------------------------------------------------|
| PROGRAM => main_program_name                    | Ada name of main subprogram.                      |
| LIBRARY => library_name                         | Name of program library.                          |
| LEVEL => CHECK   BIND   LINK                    | Specify level of bind.                            |
| EXECUTION => AUTOMATIC   DYNAMIC   PROTECTED    | Controls use of dynamic loader.                   |
| OBJECT => AUTOMATIC   file_name                 | Name of object module.                            |
| UNCALLED => REMOVE   KEEP                       | Removes or keeps uncalled subprograms.            |
| SLICE => NO   positive_integer                  | Define time-slice.                                |
| MAIN => positive_integer                        | Size of main stack.                               |
| TASK => positive_integer                        | Size of task stack.                               |
| HISTORY => YES   NO                             | Generate stack traces for unhandled exceptions?   |
| SIZE => positive_integer                        | Size the initial heap allocation.                 |
| INCREMENT => positive_integer                   | Size subsequent heap allocations.                 |
| DIRECTIVES => options_for_linker                | Supplies linker directives.                       |
| MODULES => file_names                           | Additional object modules.                        |
| SEARCH => library_names                         | Additional object libraries.                      |
| OUTPUT => SCREEN   NONE   AUTOMATIC   file_name | Location of binder listing.                       |
| DATA => BIND   LINK   ALL   NONE                | Amount of data to be included in binder listings. |
| WARNING => YES   NO                             | Generate warning messages?                        |
| DEBUG => YES   NO                               | Generate debug information?                       |

## APPENDIX C

### APPENDIX F OF THE Ada STANDARD

The only allowed implementation dependencies correspond to implementation-dependent pragmas, to certain machine-dependent conventions as mentioned in Chapter 13 of the Ada Standard, and to certain allowed restrictions on representation clauses. The implementation-dependent characteristics of this Ada implementation, as described in this Appendix, are provided by the customer. Unless specifically noted otherwise, references in this Appendix are to compiler documentation and not to this report. Implementation-specific portions of the package STANDARD, which are not a part of Appendix F, are:

package STANDARD is

type INTEGER is range -32\_768..32\_767;

type FLOAT is digits 6 range

-2#1.111\_1111\_1111\_1111\_1111\_1111#E+127..

2#1.111\_1111\_1111\_1111\_1111\_1111#E+127;

type DURATION is delta 2#0.000\_000\_000\_000\_01# range

-131072.00000..131071.99994;

type SHORT\_INTEGER is range -128..127;

type LONG\_INTEGER is range -2\_147\_483\_648..2\_147\_483\_647;

type SHORT\_FLOAT is digits 6 range

-2#1.111\_1111\_1111\_1111\_1111\_1111#E+127 ..

2#1.111\_1111\_1111\_1111\_1111\_1111#E+127;

type LONG\_FLOAT is digits 15 range

-2#1.1111\_1111\_1111\_1111\_1111\_1111\_1111\_1111\_1111\_1111\_1111\_1111\_1111\_1111\_1111\_1111#E+1023

2#1.1111\_1111\_1111\_1111\_1111\_1111\_1111\_1111\_1111\_1111\_1111\_1111\_1111\_1111\_1111\_1111#E+1023;

...

end STANDARD;

**Alsys Ada Software Development Environment**

**for BTOS II**

**APPENDIX F**

**Version 5**

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## APPENDIX F

### Implementation - Dependent Characteristics

This appendix summarizes the implementation-dependent characteristics of the Alsys Ada Software Development Environment for BTOS II. Appendix F is a required part of the *Reference Manual for the Ada Programming Language* (called the RM in this appendix).

The sections of this appendix are as follows:

1. The form, allowed places, and effect of every implementation-dependent pragma.
2. The name and the type of every implementation-dependent attribute.
3. The specification of the package SYSTEM.
4. The description of the representation clauses.
5. The conventions used for any implementation-generated name denoting implementation-dependent components.
6. The interpretation of expressions that appear in address clauses, including those for interrupts.
7. Any restrictions on unchecked conversions.
8. Any implementation-dependent characteristics of the input-output packages.
9. Characteristics of numeric types.
10. Other implementation-dependent characteristics.
11. Compiler limitations.

The name *Alsys Runtime Executive Programs* or simply *Runtime Executive* refers to the runtime library routines provided for all Ada programs. These routines implement the Ada heap, exceptions, tasking control, and other utility functions.

General systems programming notes are given in another document, the *Application Developer's Guide* (for example, parameter passing conventions needed for interface with assembly routines).

## Section 1

### Implementation-Dependent Pragmas

#### 1.1 *INLINE*

Pragma *INLINE* is fully supported; however, it is not possible to inline a subprogram in a declarative part.

#### 1.2 *INTERFACE*

Ada programs can interface with subprograms written in Assembler and other languages through the use of the predefined pragma *INTERFACE* and the implementation-defined pragma *INTERFACE\_NAME*.

Pragma *INTERFACE* specifies the name of an interfaced subprogram and the name of the programming language for which parameter passing conventions will be generated. Pragma *INTERFACE* takes the form specified in the RM:

```
pragma INTERFACE (language_name, subprogram_name);
```

where,

- *language\_name* is *ASSEMBLER* or *ADA*.
- *subprogram\_name* is the name used within the Ada program to refer to the interfaced subprogram.

The only language names accepted by pragma *INTERFACE* are *ASSEMBLER* or *ADA*. The full implementation requirements for writing pragma *INTERFACE* subprograms are described in the *Application Developer's Guide*.

The language name used in the pragma *INTERFACE* does not have to have any relationship to the language actually used to write the interfaced subprogram. It is used only to tell the Compiler how to generate subprogram calls; that is, what kind of parameter passing techniques to use. The programmer can interface Ada programs with subroutines written in any other (compiled) language by understanding the mechanisms

used for parameter passing by the compiler and the corresponding mechanisms of the chosen external language.

### 1.3 INTERFACE\_NAME

Pragma `INTERFACE_NAME` associates the name of the interfaced subprogram with the external name of the interfaced subprogram. If pragma `INTERFACE_NAME` is not used, then the two names are assumed to be identical. This pragma takes the form:

```
pragma INTERFACE_NAME (subprogram_name, string_literal);
```

where,

- *subprogram\_name* is the name used within the Ada program to refer to the interfaced subprogram.
- *string\_literal* is the name by which the interfaced subprogram is referred to at link time.

The pragma `INTERFACE_NAME` is used to identify routines in other languages that are not named with legal Ada identifiers. Ada identifiers can only contain letters, digits, or underscores, whereas the BTOS II Linker allows external names to contain other characters, for example, the dollar sign (\$) or commercial at sign (@). These characters can be specified in the *string\_literal* argument of the pragma `INTERFACE_NAME`.

The pragma `INTERFACE_NAME` is allowed at the same places of an Ada program as the pragma `INTERFACE`. (Location restrictions can be found in section 13.9 of the RM.) However, the pragma `INTERFACE_NAME` must always occur after the pragma `INTERFACE` declaration for the interfaced subprogram.

The *string\_literal* of the pragma `INTERFACE_NAME` is passed through unchanged to the BTOS II object file. The maximum length of the *string\_literal* is 40 characters. This limit is not checked by the Compiler, but the string is truncated by the Binder to meet the Intel object module format standard.

The user must be aware however, that some tools from other vendors do not fully support the standard Intel object file format and may restrict the length of symbols. For example, the Microsoft assemblers silently truncate symbols at 31 characters.

The *Runtime Executive* contains several external identifiers. All such identifiers begin with either the string "ADA@" or the string "ADAS@". Accordingly, names prefixed by "ADA@" or "ADAS@" should be avoided by the user.

### *Example*

```
package SAMPLE_DATA is
  function SAMPLE_DEVICE (X: INTEGER) return INTEGER;
  function PROCESS_SAMPLE (X: INTEGER) return INTEGER;
private
  pragma INTERFACE (ASSEMBLER, SAMPLE_DEVICE);
  pragma INTERFACE (ADA, PROCESS_SAMPLE);
  pragma INTERFACE_NAME (SAMPLE_DEVICE, "DEVIO$GET_SAMPLE");
end SAMPLE_DATA;
```

## 1.4 INDENT

Pragma *INDENT* is only used with *AdaReformat*. *AdaReformat* is the Alsys reformatter which offers the functionalities of a pretty-printer in an Ada environment.

The pragma is placed in the source file and interpreted by the Reformatter. The line

```
pragma INDENT(OFF);
```

causes *AdaReformat* not to modify the source lines after this pragma, while

```
pragma INDENT(ON);
```

causes *AdaReformat* to resume its action after this pragma.

## 1.5 Other Pragmas

Pragmas *IMPROVE* and *PACK* are discussed in detail in the section on representation clauses and records (Chapter 4).

Pragma *PRIORITY* is accepted with the range of priorities running from 1 to 10 (see the definition of the predefined package *SYSTEM* in Section 3). Undefined priority (no pragma *PRIORITY*) is treated as though it were less than any defined priority value.

In addition to pragma *SUPPRESS*, it is possible to suppress all checks in a given compilation by the use of the Compiler option *CHECKS*. (See Chapter 4 of the *User's Guide*.)



## Section 2

### Implementation-Dependent Attributes

#### 2.1 P'IS\_ARRAY

For a prefix P that denotes any type or subtype, this attribute yields the value TRUE if P is an array type or an array subtype; otherwise, it yields the value FALSE.

#### 2.2 E'EXCEPTION\_CODE

For a prefix E that denotes an exception name, this attribute yields a value that represents the internal code of the exception. The value of this attribute is of the type INTEGER.

#### 2.3 Attributes Used in Record Representation Clauses

In addition to the Representation Attributes of [13.7.2] and [13.7.3], the following attributes are used to form names of indirect and implicit components for use in record representation clauses, as described in Section 4.8.

- 'OFFSET
- 'RECORD\_SIZE
- 'VARIANT\_INDEX
- 'ARRAY\_DESCRIPTOR
- 'RECORD\_DESCRIPTION





## Section 3

### Specification of the package SYSTEM

The implementation does not allow the recompilation of package SYSTEM.

package SYSTEM is

```
-- *****
-- * (1) Required Definitions. *
-- *****

type NAME is (180X86);
SYSTEM_NAME : constant NAME := 180X86;

STORAGE_UNIT : constant := 8;
MEMORY_SIZE : constant := 2**24;

-- System-Dependent Named Numbers:
MAX_INT : constant := 2**31 - 1;
MIN_INT : constant := - (2**31);
MAX_MANTISSA : constant := 31;
FINE_DELTA : constant := 2#1.0#E-31;
MAX_DIGITS : constant := 15;

-- For the high-resolution timer, the clock resolution is
-- 1.0 / 1024.0.
TICK : constant := 0.1;
```

```

-- Other System-Dependent Declarations:
subtype PRIORITY is INTEGER range 1 .. 10;

-- The type ADDRESS is, in fact, implemented as a
-- segment:offset pair.
type ADDRESS is private;
NULL_ADDRESS : constant ADDRESS;

-- *****
-- * (2) Operations on Address *
-- *****

-- VALUE converts a string to an address. The syntax of the string and its
-- meaning are target dependent.
--
-- For the 8086, 80186 and 80286 the syntax is:
-- "SSSS:0000" where SSSS and 0000 are a 4 digit or less hexadecimal
-- number representing a segment value and an offset.
-- The physical address corresponding to SSSS:0000 depends
-- on the execution mode. In real mode it is 16*SSSS+0000.
-- In protected mode the value SSSS represents a segment
-- descriptor.
-- Example:
-- "0014:00F0"
--
-- The exception CONSTRAINT_ERROR is raised if the string does not have
-- the proper syntax.

function VALUE (LEFT : in STRING) return ADDRESS;

```

```
-- IMAGE converts an address to a string. The syntax of the returned string
-- is described in the VALUE function.
```

```
subtype ADDRESS_STRING is STRING(1..9);
```

```
function IMAGE (LEFT : in ADDRESS) return ADDRESS_STRING;
```

```
-- SAME_SEGMENT returns true if the two addresses have
-- the same segment value.
```

```
function SAME_SEGMENT (LEFT, RIGHT : in ADDRESS) return BOOLEAN;
```

```
-- The following routines provide support to perform address
-- computation. For the "+" and "-" operators the OFFSET parameter
-- is added to, or subtracted from the offset part of the address,
-- the segment remaining untouched.
```

```
type OFFSET is range 0 .. 2**16 -1;
```

```
-- The exception ADDRESS_ERROR is raised by "<", "<=", ">", ">=", "-".
-- if the two addresses do not have the same segment value.
-- The exception CONSTRAINT_ERROR can be raised by "+" and "-".
```

```
ADDRESS_ERROR : exception;
```

```
function "+" (LEFT : in ADDRESS; RIGHT : in OFFSET) return ADDRESS;
```

```
function "+" (LEFT : in OFFSET; RIGHT : in ADDRESS) return ADDRESS;
```

```
function "-" (LEFT : in ADDRESS; RIGHT : in OFFSET) return ADDRESS;
```

```

-- The exception ADDRESS_ERROR is raised if the two addresses do
-- not have the same segment value.
function "-" (LEFT : in ADDRESS; RIGHT : in ADDRESS) return OFFSET;

-- Perform an unsigned comparison on offset part of addresses.

function "<=" (LEFT, RIGHT : in ADDRESS) return BOOLEAN;
function "<" (LEFT, RIGHT : in ADDRESS) return BOOLEAN;
function ">=" (LEFT, RIGHT : in ADDRESS) return BOOLEAN;
function ">" (LEFT, RIGHT : in ADDRESS) return BOOLEAN;

function "mod" (LEFT : in ADDRESS; RIGHT : in POSITIVE) return NATURAL;

-- Returns the given address rounded to a specific value.

type ROUND_DIRECTION is (DOWN, UP);

function ROUND (VALUE      : in ADDRESS;
                DIRECTION : in ROUND_DIRECTION;
                MODULUS    : in POSITIVE) return ADDRESS;

-- These routines are provided to perform READ/WRITE operation
-- in memory.
-- Warning: These routines will give unexpected results if used with
-- unconstrained types.

generic
    type TARGET is private;
function FETCH_FROM_ADDRESS (A : in ADDRESS) return TARGET;

generic
    type TARGET is private;
procedure ASSIGN_TO_ADDRESS (A : in ADDRESS; T : in TARGET);

```

```

-- Procedure to copy LENGTH storage unit starting at the address
-- FROM to the address TO. The source and destination may overlap.
-- OBJECT_LENGTH designates the size of an object in storage units.

type OBJECT_LENGTH is range 0 .. 2**16 -1;
for OBJECT_LENGTH'SIZE use 16;

procedure MOVE (TO      : in ADDRESS;
               FROM     : in ADDRESS;
               LENGTH   : in OBJECT_LENGTH);
private
    ...

end SYSTEM;
```



## Section 4

### Support for Representation Clauses

This section explains how objects are represented and allocated and how it is possible to control this using representation clauses. Applicable restrictions on representation clauses are also described.

The representation of an object is closely connected with its type. For this reason this section addresses successively the representation of enumeration, integer, floating point, fixed point, access, task, array and record types. For each class of type the representation of the corresponding objects is described.

Except in the case of array and record types, the description for each class of type is independent of the others. To understand the representation of array and record types it is necessary to understand first the representation of their components.

Apart from implementation defined pragmas, Ada provides three means to control the size of objects:

- a (predefined) pragma PACK, applicable to array types
- a record representation clause
- a size specification

For each class of types the effect of a size specification is described. Interactions among size specifications, packing and record representation clauses is described under the discussion of array and record types.

Representation clauses on derived record types or derived tasks types are not supported.

Size representation clauses on types derived from private types are not supported when the derived type is declared outside the private part of the defining package.

## 4.1 Enumeration Types

### 4.1.1 Enumeration Literal Encoding

When no enumeration representation clause applies to an enumeration type, the internal code associated with an enumeration literal is the position number of the enumeration literal. Then, for an enumeration type with  $n$  elements, the internal codes are the integers 0, 1, 2, ..,  $n-1$ .

An enumeration representation clause can be provided to specify the value of each internal code as described in RM 13.3. The Alsys compiler fully implements enumeration representation clauses.

As internal codes must be machine integers the internal codes provided by an enumeration representation clause must be in the range  $-2^{31} .. 2^{31}-1$ .

An enumeration value is always represented by its internal code in the program generated by the compiler.

### 4.1.2 Enumeration Types and Object Sizes

#### *Minimum size of an enumeration subtype*

The minimum possible size of an enumeration subtype is the minimum number of bits that is necessary for representing the internal codes of the subtype values in normal binary form.

A static subtype, with a null range has a minimum size of 1. Otherwise, if  $m$  and  $M$  are the values of the internal codes associated with the first and last enumeration values of the subtype, then its minimum size  $L$  is determined as follows. For  $m \geq 0$ ,  $L$  is the smallest positive integer such that  $M \leq 2^L - 1$ . For  $m < 0$ ,  $L$  is the smallest positive integer such that  $-2^{L-1} \leq m$  and  $M \leq 2^{L-1} - 1$ . For example:

**type** COLOR **is** (GREEN, BLACK, WHITE, RED, BLUE, YELLOW);  
-- The minimum size of COLOR is 3 bits.

**subtype** BLACK\_AND\_WHITE **is** COLOR **range** BLACK .. WHITE;  
-- The minimum size of BLACK\_AND\_WHITE is 2 bits.



subtype BLACK\_OR\_WHITE is BLACK\_AND\_WHITE range X .. X;  
 -- Assuming that X is not static, the minimum size of BLACK\_OR\_WHITE is  
 -- 2 bits (the same as the minimum size of its type mark BLACK\_AND\_WHITE).

#### *Size of an enumeration subtype*

When no size specification is applied to an enumeration type or first named subtype, the objects of that type or first named subtype are represented as signed machine integers. The machine provides 8, 16 and 32 bit integers, and the compiler selects automatically the smallest signed machine integer which can hold each of the internal codes of the enumeration type (or subtype). The size of the enumeration type and of any of its subtypes is thus 8, 16 or 32 bits.

When a size specification is applied to an enumeration type, this enumeration type and each of its subtypes has the size specified by the length clause. The same rule applies to a first named subtype. The size specification must of course specify a value greater than or equal to the minimum size of the type or subtype to which it applies:

type EXTENDED is  
 (-- The usual ASCII character set.  
 NUL, SOH, STX, ETX, EOT, ENQ, ACK, BEL,  
 ...  
 'x', 'y', 'z', '{', '|', '}', '~', DEL,  
 -- Extended characters  
 C\_CEDILLA\_CAP, U\_UMLAUT, E\_ACUTE, ...);

for EXTENDED'SIZE use 8;  
 -- The size of type EXTENDED will be one byte. Its objects will be represented  
 -- as unsigned 8 bit integers.

The Alsys compiler fully implements size specifications. Nevertheless, as enumeration values are coded using integers, the specified length cannot be greater than 32 bits.

#### *Size of the objects of an enumeration subtype*

Provided its size is not constrained by a record component clause or a pragma PACK, an object of an enumeration subtype has the same size as its subtype.

## 4.2 Integer Types

There are three predefined integer types in the Alsys Ada Software Development Environment for BTOS II implementation:

|                           |                                    |
|---------------------------|------------------------------------|
| <b>type</b> SHORT_INTEGER | <b>is range</b> -2**07 .. 2**07-1; |
| <b>type</b> INTEGER       | <b>is range</b> -2**15 .. 2**15-1; |
| <b>type</b> LONG_INTEGER  | <b>is range</b> -2**31 .. 2**31-1; |

### 4.2.1 Integer Type Representation

An integer type declared by a declaration of the form:

**type** T **is range** L .. R;

is implicitly derived from a predefined integer type. The compiler automatically selects the predefined integer type whose range is the smallest that contains the values L to R inclusive.

Binary code is used to represent integer values. Negative numbers are represented using two's complement.

### 4.2.2 Integer Type and Object Size

#### *Minimum size of an integer subtype*

The minimum possible size of an integer subtype is the minimum number of bits that is necessary for representing the internal codes of the subtype values in normal binary form.

For a static subtype, if it has a null range its minimum size is 1. Otherwise, if m and M are the lower and upper bounds of the subtype, then its minimum size L is determined as follows. For  $m \geq 0$ , L is the smallest positive integer such that  $M \leq 2^{L-1}$ . For  $m < 0$ , L is the smallest positive integer that  $-2^{L-1} \leq m$  and  $M \leq 2^{L-1}-1$ . For example:

**subtype** S **is** INTEGER **range** 0 .. 7;  
-- The minimum size of S is 3 bits.

**subtype D is S range X .. Y;**

- Assuming that X and Y are not static, the minimum size of
- D is 3 bits (the same as the minimum size of its type mark S).

#### *Size of an integer subtype*

The sizes of the predefined integer types **SHORT\_INTEGER**, **INTEGER** and **LONG\_INTEGER** are respectively 8, 16 and 32 bits.

When no size specification is applied to an integer type or to its first named subtype (if any), its size and the size of any of its subtypes is the size of the predefined type from which it derives, directly or indirectly. For example:

**type S is range 80 .. 100;**

- S is derived from **SHORT\_INTEGER**, its size is 8 bits.

**type J is range 0 .. 255;**

- J is derived from **INTEGER**, its size is 16 bits.

**type N is new J range 80 .. 100;**

- N is indirectly derived from **INTEGER**, its size is 16 bits.

When a size specification is applied to an integer type, this integer type and each of its subtypes has the size specified by the length clause. The same rule applies to a first named subtype. The size specification must of course specify a value greater than or equal to the minimum size of the type or subtype to which it applies:

**type S is range 80 .. 100;**

**for S'SIZE use 32;**

- S is derived from **SHORT\_INTEGER**, but its size is 32 bits
- because of the size specification.

**type J is range 0 .. 255;**

**for J'SIZE use 8;**

- J is derived from **INTEGER**, but its size is 8 bits because
- of the size specification.

**type N is new J range 80 .. 100;**

- N is indirectly derived from **INTEGER**, but its size is
- 8 bits because N inherits the size specification of J.

#### *Size of the objects of an integer subtype*

Provided its size is not constrained by a record component clause or a pragma PACK, an object of an integer subtype has the same size as its subtype.

### **4.3 Floating Point Types**

There are three predefined floating point types in the Alsys implementation: for ISOx86 machines:

**type** SHORT\_FLOAT is

digits 6 range  $-(2.0 - 2.0^{**}(-23)) * 2.0^{**127} .. (2.0 - 2.0^{**}(-23)) * 2.0^{**127}$ ;

**type** FLOAT is

digits 6 range  $-(2.0 - 2.0^{**}(-23)) * 2.0^{**127} .. (2.0 - 2.0^{**}(-23)) * 2.0^{**127}$ ;

**type** LONG\_FLOAT is

digits 15 range  $-(2.0 - 2.0^{**}(-52)) * 2.0^{**1023} .. (2.0 - 2.0^{**}(-52)) * 2.0^{**1023}$ ;

Note that SHORT\_FLOAT has the same range as FLOAT.

#### **4.3.1 Floating Point Type Representation**

A floating point type declared by a declaration of the form:

**type** T is digits D [range L .. R];

is implicitly derived from a predefined floating point type. The compiler automatically selects the smallest predefined floating point type whose number of digits is greater than or equal to D and which contains the values L to R inclusive.

In the program generated by the compiler, floating point values are represented using the IEEE standard formats for single and double floats.

The values of the predefined types SHORT\_FLOAT and FLOAT are represented using the single float format. The values of the predefined type LONG\_FLOAT are represented using the double float format. The values of any other floating point type are represented in the same way as the values of the predefined type from which it derives, directly or indirectly.

### 4.3.2 Floating Point Type and Object Size

The minimum possible size of a floating point subtype is 32 bits if its base type is `SHORT_FLOAT` or `FLOAT` or a type derived from `SHORT_FLOAT` or `FLOAT`; it is 64 bits if its base type is `LONG_FLOAT` or a type derived from `LONG_FLOAT`.

The sizes of the predefined floating point types `SHORT_FLOAT` and `FLOAT` is 32 bits and `LONG_FLOAT` is 64 bits.

The size of a floating point type and the size of any of its subtypes is the size of the predefined type from which it derives directly or indirectly.

The only size that can be specified for a floating point type or first named subtype using a size specification is its usual size (32 or 64 bits).

An object of a floating point subtype has the same size as its subtype.

## 4.4 Fixed Point Types

### 4.4.1 Fixed Point Type Representation

If no specification of `small` applies to a fixed point type, then the value of `small` is determined by the value of `delta` as defined by RM 3.5.9.

A specification of `small` can be used to impose a value of `small`. The value of `small` is required to be a power of two.

To implement fixed point types, the Alsys Ada Software Development Environment for BTOS II uses a set of anonymous predefined types of the form:

```
type SHORT_FIXED is delta D range (-2.0**7-1)*S .. 2.0**7*S;  
for SHORT_FIXED'SMALL use S;
```

```
type FIXED is delta D range (-2.0**15-1)*S .. 2.0**15*S;  
for FIXED'SMALL use S;
```

```
type LONG_FIXED is delta D range (-2.0**31-1)*S .. 2.0**31*S;  
for LONG_FIXED'SMALL use S;
```

where `D` is any real value and `S` any power of two less than or equal to `D`.

A fixed point type declared by a declaration of the form:

**type T is delta D range L .. R;**

possibly with a small specification:

**for TSMALL use S;**

is implicitly derived from a predefined fixed point type. The compiler automatically selects the predefined fixed point type whose small and delta are the same as the small and delta of T and whose range is the shortest that includes the values L to R inclusive.

In the program generated by the compiler, a safe value V of a fixed point subtype F is represented as the integer:

$V / F\text{BASE}^{\text{SMALL}}$

#### 4.4.2 Fixed Point Type and Object Size

##### *Minimum size of a fixed point subtype*

The minimum possible size of a fixed point subtype is the minimum number of binary digits that is necessary for representing the values of the range of the subtype using the small of the base type.

For a static subtype, if it has a null range its minimum size is 1. Otherwise, s and S being the bounds of the subtype, if i and I are the integer representations of m and M, the smallest and the greatest model numbers of the base type such that  $s < m$  and  $M < S$ , then the minimum size L is determined as follows. For  $i \geq 0$ , L is the smallest positive integer such that  $I \leq 2^{L-1}$ . For  $i < 0$ , L is the smallest positive integer such that  $-2^{L-1} \leq i$  and  $I \leq 2^{L-1}-1$ .

**type F is delta 2.0 range 0.0 .. 500.0;**

-- The minimum size of F is 8 bits.

**subtype S is F delta 16.0 range 0.0 .. 250.0;**

-- The minimum size of S is 7 bits.

**subtype D is S range X .. Y;**

-- Assuming that X and Y are not static, the minimum size of D is 7 bits

-- (the same as the minimum size of its type mark S).

### *Size of a fixed point subtype*

The sizes of the predefined fixed point types `SHORT_FIXED`, `FIXED` and `LONG_FIXED` are respectively 8, 16 and 32 bits.

When no size specification is applied to a fixed point type or to its first named subtype, its size and the size of any of its subtypes is the size of the predefined type from which it derives directly or indirectly. For example:

**type S is delta 0.01 range 0.8 .. 1.0;**

-- S is derived from an 8 bit predefined fixed type, its size is 8 bits.

**type F is delta 0.01 range 0.0 .. 2.0;**

-- F is derived from a 16 bit predefined fixed type, its size is 16 bits.

**type N is new F range 0.8 .. 1.0;**

-- N is indirectly derived from a 16 bit predefined fixed type, its size is 16 bits.

When a size specification is applied to a fixed point type, this fixed point type and each of its subtypes has the size specified by the length clause. The same rule applies to a first named subtype. The size specification must of course specify a value greater than or equal to the minimum size of the type or subtype to which it applies:

**type S is delta 0.01 range 0.8 .. 1.0;**

**for S'SIZE use 32;**

-- S is derived from an 8 bit predefined fixed type, but its size is 32 bits

-- because of the size specification.

**type F is delta 0.01 range 0.0 .. 2.0;**

**for F'SIZE use 8;**

-- F is derived from a 16 bit predefined fixed type, but its size is 8 bits

-- because of the size specification.

**type N is new F range 0.8 .. 1.0;**

-- N is indirectly derived from a 16 bit predefined fixed type, but its size is

-- 8 bits because N inherits the size specification of F.

The Alsys compiler fully implements size specifications. Nevertheless, as fixed point objects are represented using machine integers, the specified length cannot be greater than 32 bits.

#### *Size of the objects of a fixed point subtype*

Provided its size is not constrained by a record component clause or a pragma PACK, an object of a fixed point type has the same size as its subtype.

## **4.5 Access Types and Collections**

#### *Access Types and Objects of Access Types*

The only size that can be specified for an access type using a size specification is its usual size (32 bits).

An object of an access subtype has the same size as its subtype, thus an object of an access subtype is always 32 bits long.

#### *Collection Size*

As described in RM 13.2, a specification of collection size can be provided in order to reserve storage space for the collection of an access type.

When no STORAGE\_SIZE specification applies to an access type, no storage space is reserved for its collection, and the value of the attribute STORAGE\_SIZE is then 0.

The maximum size allowed for a collection is 64k bytes.

## **4.6 Task Types**

#### *Storage for a task activation*

As described in RM 13.2, a length clause can be used to specify the storage space (that is, the stack size) for the activation of each of the tasks of a given type. Alsys also allows the task stack size, for all tasks, to be established using a Binder option. If a length clause is given for a task type, the value indicated at bind time is ignored for this task type, and the length clause is obeyed. When no length clause is used to specify the storage space to be



reserved for a task activation, the storage space indicated at bind time is used for this activation.

A length clause may not be applied to a derived task type. The same storage space is reserved for the activation of a task of a derived type as for the activation of a task of the parent type.

The minimum size of a task subtype is 32 bits.

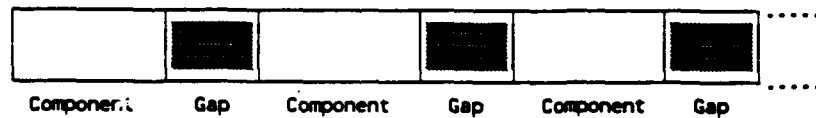
A size specification has no effect on a task type. The only size that can be specified using such a length clause is its usual size (32 bits).

An object of a task subtype has the same size as its subtype. Thus an object of a task subtype is always 32 bits long.

## 4.7 Array Types

Each array is allocated in a contiguous area of storage units. All the components have the same size. A gap may exist between two consecutive components (and after the last one). All the gaps have the same size.

### 4.7.1 Array Layout and Structure and Pragma PACK



If `pragma PACK` is not specified for an array, the size of the components is the size of the subtype of the components:

type A is array (1 .. 8) of BOOLEAN;

-- The size of the components of A is the size of the type BOOLEAN: 8 bits.

type DECIMAL\_DIGIT is range 0 .. 9;

for DECIMAL\_DIGIT'SIZE use 4;

type BINARY\_CODED\_DECIMAL is

array (INTEGER range <>) of DECIMAL\_DIGIT;

-- The size of the type DECIMAL\_DIGIT is 4 bits. Thus in an array of

-- type BINARY\_CODED\_DECIMAL each component will be represented on

-- 4 bits as in the usual BCD representation.

If pragma PACK is specified for an array and its components are neither records nor arrays, the size of the components is the minimum size of the subtype of the components:

type A is array (1 .. 8) of BOOLEAN;

pragma PACK(A);

-- The size of the components of A is the minimum size of the type BOOLEAN:

-- 1 bit.

type DECIMAL\_DIGIT is range 0 .. 9;

for DECIMAL\_DIGIT'SIZE use 32;

type BINARY\_CODED\_DECIMAL is

array (INTEGER range <>) of DECIMAL\_DIGIT;

pragma PACK(BINARY\_CODED\_DECIMAL);

-- The size of the type DECIMAL\_DIGIT is 32 bits, but, as

-- BINARY\_CODED\_DECIMAL is packed, each component of an array of this

-- type will be represented on 4 bits as in the usual BCD representation.

Packing the array has no effect on the size of the components when the components are records or arrays, since records and arrays may be assigned addresses consistent with the alignment of their subtypes.

### *Gaps*

If the components are records or arrays, no size specification applies to the subtype of the components and the array is not packed, then the compiler may choose a representation with a gap after each component; the aim of the insertion of such gaps is to optimize access to the array components and to their subcomponents. The size of the gap is chosen so that the relative displacement of consecutive components is a multiple

of the alignment of the subtype of the components. This strategy allows each component and subcomponent to have an address consistent with the alignment of its subtype:

```

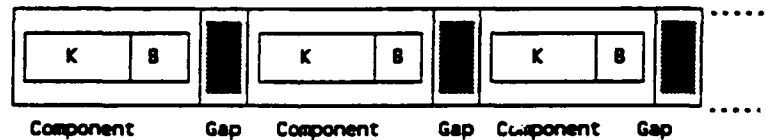
type R is
  record
    K : INTEGER;
    B : BOOLEAN;
  end record;
for R use
  record
    K at 0 range 0 .. 15;
    B at 2 range 0 .. 0;
  end record;
-- Record type R is byte aligned. Its size is 17 bits.

```

```

type A is array (1 .. 10) of R;
-- A gap of 7 bits is inserted after each component in order to respect the
-- alignment of type R. The size of an array of type A will be 240 bits.

```



*Array of type A: each subcomponent K has an even offset.*

If a size specification applies to the subtype of the components or if the array is packed, no gaps are inserted:

```

type R is
  record
    K : INTEGER;
    B : BOOLEAN;
  end record;

type A is array (1 .. 10) of R;
pragma PACK(A);
-- There is no gap in an array of type A because A is packed.
-- The size of an object of type A will be 270 bits.

```

```

type NR is new R;
for NR'SIZE use 24;

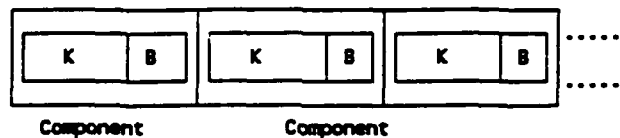
```

```

type B is array (1 .. 10) of NR;

```

- There is no gap in an array of type B because
- NR has a size specification.
- The size of an object of type B will be 240 bits.



*Array of type A or B*

#### 4.7.2 Array Subtype and Object Size

##### *Size of an array subtype*

The size of an array subtype is obtained by multiplying the number of its components by the sum of the size of the components and the size of the gaps (if any). If the subtype is unconstrained, the maximum number of components is considered.

The size of an array subtype cannot be computed at compile time

- if it has non-static constraints or is an unconstrained array type with non-static index subtypes (because the number of components can then only be determined at run time).
- if the components are records or arrays and their constraints or the constraints of their subcomponents (if any) are not static (because the size of the components and the size of the gaps can then only be determined at run time).

As has been indicated above, the effect of a pragma PACK on an array type is to suppress the gaps. The consequence of packing an array type is thus to reduce its size.

If the components of an array are records or arrays and their constraints or the constraints of their subcomponents (if any) are not static, the compiler ignores any pragma PACK applied to the array type but issues a warning message. Apart from this limitation, array packing is fully implemented by the Alsys compiler.

A size specification applied to an array type or first named subtype has no effect. The only size that can be specified using such a length clause is its usual size. Nevertheless, such a length clause can be useful to verify that the layout of an array is as expected by the application.

#### *Size of the objects of an array subtype*

The size of an object of an array subtype is always equal to the size of the subtype of the object.

## 4.8 Record Types

### 4.8.1 Basic Record Structure

#### *Layout of a record*

Each record is allocated in a contiguous area of storage units. The size of a record component depends on its type.

The positions and the sizes of the components of a record type object can be controlled using a record representation clause as described in RM 13.4. In the Alsys Ada Software Development Environment for BTOS II implementation there is no restriction on the position that can be specified for a component of a record. If a component is not a record or an array, its size can be any size from the minimum size to the size of its subtype. If a component is a record or an array, its size must be the size of its subtype.

```
type DEVICE_INFO_RECORD is
  record
    BIT15 : BOOLEAN; -- Bit 15 (reserved)
    CTRL  : BOOLEAN; -- Bit 14 (true if control strings processed)
    NETWORK : BOOLEAN; -- Bit 13 (true if device is on network)
    BIT12 : BOOLEAN; -- Bit 12 (reserved)
    BIT11 : BOOLEAN; -- Bit 11 (reserved)
    BIT10 : BOOLEAN; -- Bit 10 (reserved)
    BIT9  : BOOLEAN; -- Bit 9 (reserved)
    BIT8  : BOOLEAN; -- Bit 8 (reserved)
    ISDEV : BOOLEAN; -- Bit 7 (true if device, false if disk file)
```

```

EOF      : BOOLEAN;  -- Bit 6 (true if at end of file)
BINARY   : BOOLEAN;  -- Bit 5 (true if binary (raw) mode)
BIT4     : BOOLEAN;  -- Bit 4 (reserved)
ISCLK    : BOOLEAN;  -- Bit 3 (true if clock device)
ISMUL    : BOOLEAN;  -- Bit 2 (true if MUL device)
ISCOT    : BOOLEAN;  -- Bit 1 (true if console output device)
ISCIN    : BOOLEAN;  -- Bit 0 (true if console input device)
end record;

```

```

for DEVICE_INFO_RECORD use
  record
    BIT15    at 1 range 7 .. 7;  -- Bit 15
    CTRL     at 1 range 6 .. 6;  -- Bit 14
    NETWORK  at 1 range 5 .. 5;  -- Bit 13
    BIT12    at 1 range 4 .. 4;  -- Bit 12
    BIT11    at 1 range 3 .. 3;  -- Bit 11
    BIT10    at 1 range 2 .. 2;  -- Bit 10
    BIT9     at 1 range 1 .. 1;  -- Bit 9
    BIT8     at 1 range 0 .. 0;  -- Bit 8
    ISDEV    at 0 range 7 .. 7;  -- Bit 7
    EOF      at 0 range 6 .. 6;  -- Bit 6
    BINARY   at 0 range 5 .. 5;  -- Bit 5
    BIT4     at 0 range 4 .. 4;  -- Bit 4
    ISCLK    at 0 range 3 .. 3;  -- Bit 3
    ISMUL    at 0 range 2 .. 2;  -- Bit 2
    ISCOT    at 0 range 1 .. 1;  -- Bit 1
    ISCIN    at 0 range 0 .. 0;  -- Bit 0
  end record;

```

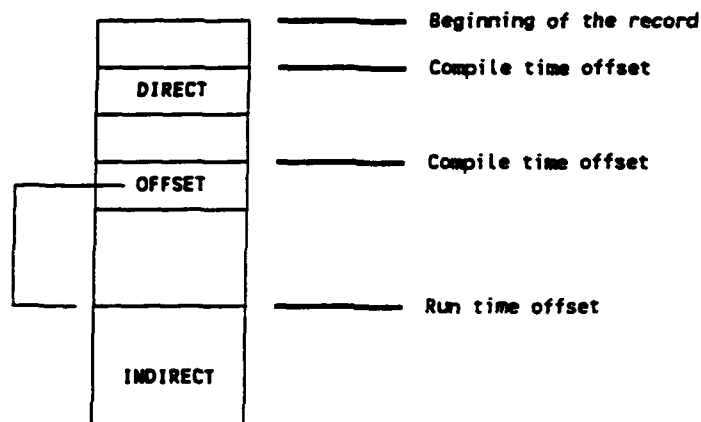
Pragma PACK has no effect on records. It is unnecessary because record representation clauses provide full control over record layout.

A record representation clause need not specify the position and the size for every component. If no component clause applies to a component of a record, its size is the size of its subtype.

## 4.8.2 Indirect Components

### 'OFFSET

If the offset of a component cannot be computed at compile time, this offset is stored in the record objects at run time and used to access the component. Such a component is said to be indirect while other components are said to be direct:



*A direct and an indirect component*

If a record component is a record or an array, the size of its subtype may be evaluated at run time and may even depend on the discriminants of the record. We will call these components dynamic components:

**type** DEVICE **is** (SCREEN, PRINTER);

**type** COLOR **is** (GREEN, RED, BLUE);

**type** SERIES **is** array (POSITIVE range < >) of INTEGER;

**type** GRAPH (L : NATURAL) **is**

**record**

    X : SERIES(1 .. L); -- The size of X depends on L

    Y : SERIES(1 .. L); -- The size of Y depends on L

**end record;**

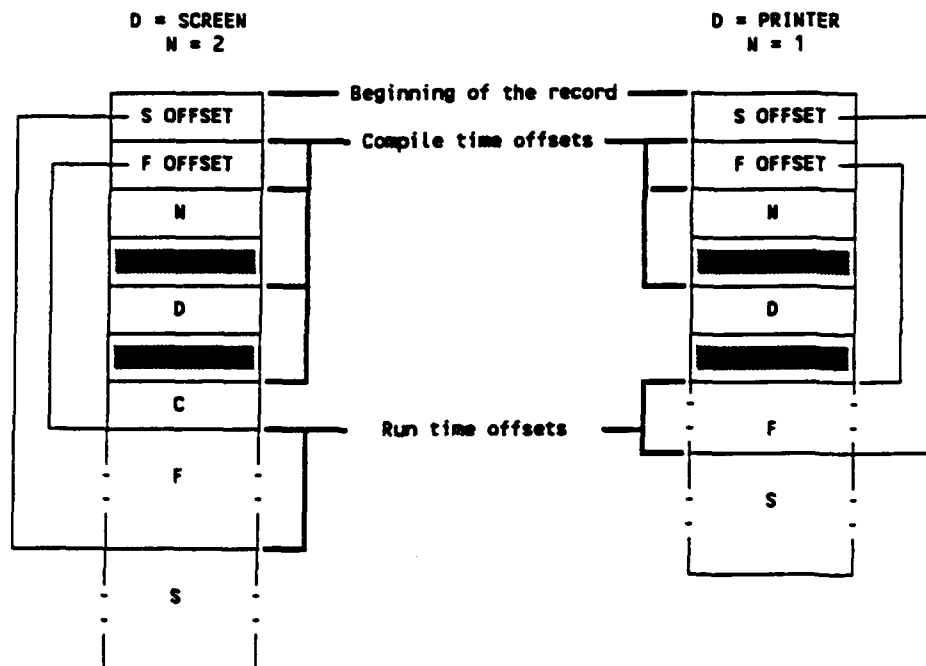
Q : POSITIVE;

```

type PICTURE (N : NATURAL; D : DEVICE) is
  record
    F : GRAPH(N); -- The size of F depends on N
    S : GRAPH(Q); -- The size of S depends on Q
  case D is
    when SCREEN =>
      C : COLOR;
    when PRINTER =>
      null;
    end case;
  end record;

```

Any component placed after a dynamic component has an offset which cannot be evaluated at compile time and is thus indirect. In order to minimize the number of indirect components, the compiler groups the dynamic components together and places them at the end of the record:

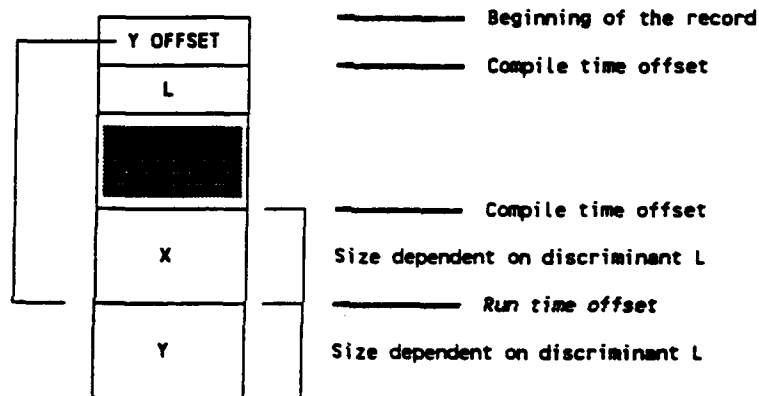


*The record type PICTURE: F and S are placed at the end of the record*



Note that Ada does not allow representation clauses for record components with non-static bounds [RM 13.4.7], so the compiler's grouping of dynamic components does not conflict with the use of representation clauses.

Because of this approach, the only indirect components are dynamic components. But not all dynamic components are necessarily indirect: if there are dynamic components in a component list which is not followed by a variant part, then exactly one dynamic component of this list is a direct component because its offset can be computed at compilation time (the only dynamic components that are direct components are in this situation):



*The record type GRAPH: the dynamic component X is a direct component.*

The offset of an indirect component is always expressed in storage units.

The space reserved for the offset of an indirect component must be large enough to store the size of any value of the record type (the maximum potential offset). The compiler evaluates an upper bound MS of this size and treats an offset as a component having an anonymous integer type whose range is 0 .. MS.

If C is the name of an indirect component, then the offset of this component can be denoted in a component clause by the implementation generated name C'OFFSET.

### 4.8.3 Implicit Components

In some circumstances, access to an object of a record type or to its components involves computing information which only depends on the discriminant values. To avoid recomputation (which would degrade performance) the compiler stores this information in the record objects, updates it when the values of the discriminants are modified and uses it when the objects or its components are accessed. This information is stored in special components called implicit components.

An implicit component may contain information which is used when the record object or several of its components are accessed. In this case the component will be included in any record object (the implicit component is considered to be declared before any variant part in the record type declaration). There can be two components of this kind; one is called `RECORD_SIZE` and the other `VARIANT_INDEX`.

On the other hand an implicit component may be used to access a given record component. In that case the implicit component exists whenever the record component exists (the implicit component is considered to be declared at the same place as the record component). Components of this kind are called `ARRAY_DESCRIPTORs` or `RECORD_DESCRIPTORs`.

#### ***'RECORD\_SIZE***

This implicit component is created by the compiler when the record type has a variant part and its discriminants are defaulted. It contains the size of the storage space necessary to store the current value of the record object (note that the storage effectively allocated for the record object may be more than this).

The value of a `RECORD_SIZE` component may denote a number of bits or a number of storage units. In general it denotes a number of storage units, but if any component clause specifies that a component of the record type has an offset or a size which cannot be expressed using storage units, then the value designates a number of bits.

The implicit component `RECORD_SIZE` must be large enough to store the maximum size of any value of the record type. The compiler evaluates an upper bound `MS` of this size and then considers the implicit component as having an anonymous integer type whose range is `0 .. MS`.

If `R` is the name of the record type, this implicit component can be denoted in a component clause by the implementation generated name `R'RECORD_SIZE`. This allows user control over the position of the implicit component in the record.

### ***VARIANT\_INDEX***

This implicit component is created by the compiler when the record type has a variant part. It indicates the set of components that are present in a record value. It is used when a discriminant check is to be done.

Component lists in variant parts that themselves do not contain a variant part are numbered. These numbers are the possible values of the implicit component **VARIANT\_INDEX**.

```
type VEHICLE is (AIRCRAFT, ROCKET, BOAT, CAR);
```

```
type DESCRIPTION (KIND : VEHICLE := CAR) is
```

```
  record
```

```
    SPEED : INTEGER;
```

```
    case KIND is
```

```
      when AIRCRAFT | CAR =>
```

```
        WHEELS : INTEGER;
```

```
        case KIND is
```

```
          when AIRCRAFT => -- 1
```

```
            WINGSPAN : INTEGER;
```

```
          when others => -- 2
```

```
            null;
```

```
        end case;
```

```
      when BOAT => -- 3
```

```
        STEAM : BOOLEAN;
```

```
      when ROCKET => -- 4
```

```
        STAGES : INTEGER;
```

```
    end case;
```

```
  end record;
```

The value of the variant index indicates the set of components that are present in a record value:

| Variant Index | Set                             |
|---------------|---------------------------------|
| 1             | (KIND, SPEED, WHEELS, WINGSPAN) |
| 2             | (KIND, SPEED, WHEELS)           |
| 3             | (KIND, SPEED, STEAM)            |
| 4             | (KIND, SPEED, STAGES)           |

A comparison between the variant index of a record value and the bounds of an interval is enough to check that a given component is present in the value:

| Component | Interval |
|-----------|----------|
| KIND      | --       |
| SPEED     | --       |
| WHEELS    | 1 .. 2   |
| WINGSPAN  | 1 .. 1   |
| STEAM     | 3 .. 3   |
| STAGES    | 4 .. 4   |

The implicit component `VARIANT_INDEX` must be large enough to store the number `V` of component lists that don't contain variant parts. The compiler treats this implicit component as having an anonymous integer type whose range is `1 .. V`.

If `R` is the name of the record type, this implicit component can be denoted in a component clause by the implementation generated name `R*VARIANT_INDEX`. This allows user control over the position of the implicit component in the record.

#### **`'ARRAY_DESCRIPTOR`**

An implicit component of this kind is associated by the compiler with each record component whose subtype is an anonymous array subtype that depends on a discriminant of the record. It contains information about the component subtype.

The structure of an implicit component of kind `ARRAY_DESCRIPTOR` is not described in this documentation. Nevertheless, if a programmer is interested in specifying the location of a component of this kind using a component clause, size of the component may be obtained using the `ASSEMBLY` parameter in the `COMPILE` command.

The compiler treats an implicit component of the kind `ARRAY_DESCRIPTOR` as having an anonymous array type. If `C` is the name of the record component whose subtype is described by the array descriptor, then this implicit component can be denoted in a component clause by the implementation generated name `C*ARRAY_DESCRIPTOR`. This allows user control over the position of the implicit component in the record.

### ***RECORD\_DESCRIPTOR***

An implicit component of this kind is associated by the compiler with each record component whose subtype is an anonymous record subtype that depends on a discriminant of the record. It contains information about the component subtype.

The structure of an implicit component of kind `RECORD_DESCRIPTOR` is not described in this documentation. Nevertheless, if a programmer is interested in specifying the location of a component of this kind using a component clause, the size of the component may be obtained using the `ASSEMBLY` parameter in the `COMPILE` command.

The compiler treats an implicit component of the kind `RECORD_DESCRIPTOR` as having an anonymous array type. If `C` is the name of the record component whose subtype is described by the record descriptor, then this implicit component can be denoted in a component clause by the implementation generated name `C'RECORD_DESCRIPTOR`. This allows user control over the position of the implicit component in the record.

### ***Suppression of Implicit Components***

The Alsys implementation provides the capability of suppressing the implicit components `RECORD_SIZE` and/or `VARIANT_INDEX` from a record type. This can be done using an implementation defined pragma called `IMPROVE`. The syntax of this pragma is as follows:

```
pragma IMPROVE ( TIME | SPACE , [ON =>] simple_name );
```

The first argument specifies whether `TIME` or `SPACE` is the primary criterion for the choice of the representation of the record type that is denoted by the second argument.

If `TIME` is specified, the compiler inserts implicit components as described above. If on the other hand `SPACE` is specified, the compiler only inserts a `VARIANT_INDEX` or a `RECORD_SIZE` component if this component appears in a record representation clause that applies to the record type. A record representation clause can thus be used to keep one implicit component while suppressing the other.

A pragma `IMPROVE` that applies to a given record type can occur anywhere that a representation clause is allowed for this type.

#### 4.8.4 Size of Record Types and Objects

##### *Size of a record subtype*

Unless a component clause specifies that a component of a record type has an offset or a size which cannot be expressed using storage units, the size of a record subtype is rounded up to a whole number of storage units.

The size of a constrained record subtype is obtained by adding the sizes of its components and the sizes of its gaps (if any). This size is not computed at compile time

- when the record subtype has non-static constraints,
- when a component is an array or a record and its size is not computed at compile time.

The size of an unconstrained record subtype is obtained by adding the sizes of the components and the sizes of the gaps (if any) of its largest variant. If the size of a component or of a gap cannot be evaluated exactly at compile time an upper bound of this size is used by the compiler to compute the subtype size.

A size specification applied to a record type or *first named subtype* has no effect. The only size that can be specified using such a length clause is its usual size. Nevertheless, such a length clause can be useful to verify that the layout of a record is as expected by the application.

##### *Size of an object of a record subtype*

An object of a constrained record subtype has the same size as its subtype.

An object of an unconstrained record subtype has the same size as its subtype if this size is less than or equal to 8k bytes. If the size of the subtype is greater than this, the object has the size necessary to store its current value; storage space is allocated and released as the discriminants of the record change.

## Section 5

### Conventions for Implementation-Generated Names

The following forms of implementation-generated names [13.4(8)] are used to denote implementation-dependent record components, as described in Section 4.8 in the sections on indirect and implicit components:

C'OFFSET  
R'RECORD\_SIZE  
R'VARIANT\_INDEX  
R'ARRAY\_DESCRIPTORs  
R'RECORD\_DESCRIPTORs

where C is the name of a record component and R the name of a record type.

The following predefined packages are reserved to Alsys and cannot be recompiled:

ALSYS\_BASIC\_IO  
ALSYS\_ADA\_RUNTIME  
ALSYS\_BASIC\_DIRECT\_IO  
ALSYS\_BASIC\_SEQUENTIAL\_IO





## Section 6

### Address Clauses

#### 6.1 Address Clauses for Objects

An address clause can be used to specify an address for an object as described in RM 13.5. When such a clause applies to an object the compiler does not cause storage to be allocated for the object. The program accesses the object using the address specified in the clause. It is the responsibility of the user therefore to make sure that a valid allocation of storage has been done at the specified address.

An address clause is not allowed for task objects, for unconstrained records whose size is greater than 8k bytes or for a constant.

There are a number of ways to compose a legal address expression for use in an address clause. The most direct ways are:

- For the case where the memory is defined in Ada as another object, use the 'ADDRESS attribute to obtain the argument for the address clause for the second object.
- For the case where the desired location is memory defined in assembly or another non-Ada language (is relocatable), an interfaced routine may be used to obtain the appropriate address from referencing information known to the other language.
- For the case where an absolute address is known to the programmer, use the function SYSTEM.VALUE. This function has one (1) parameter of type string. The string is of the form "ssss:0000". The length is 9, and the ':' is required to separate the segment and offset portion of the address. SYSTEM.VALUE returns a value of type SYSTEM.ADDRESS. The string representing the desired address can be passed as the actual parameter to SYSTEM.VALUE in the simple expression part of the address clause. See Section 3 for the specification of package SYSTEM.

In all cases other than the use of an address attribute, the programmer must ensure that the segment part of the argument is a selector if the program is to run in protected mode. Refer to the *Application Developers' Guide*, Section 5.1.5 for more information on protected mode machine oriented programming.

## **6.2 Address Clauses for Program Units**

Address clauses for program units are not implemented in the current version of the compiler.

## Section 7

### Unchecked Conversions

Unchecked type conversions are described in [13.10.2]. The following restrictions apply to their use:

- Unconstrained arrays are not allowed as target types. Unconstrained record types without defaulted discriminants are not allowed as target types. Access types to unconstrained arrays are not allowed as target or source types. Notes also that `UNCHECKED_CONVERSION` cannot be used for an access to an unconstrained string.
- If the target type has a smaller size than the source type then the target is made of the least significant bits of the source.

If the source and the target types are each of scalar or access type or if they are both of composite type, the effect of the function is to return the operand.

In other cases the effect of unchecked conversion can be considered as a copy:

- If an unchecked conversion of a scalar or access source type to a composite target type is performed, the result is a copy of the source operand. The result has the size of the source.
- If an unchecked conversion of a composite source type to a scalar or access target type is performed, the result is a copy of the source operand. The result has the size of the target.



## Section 8

### Input-Output Packages

The RM defines the predefined input-output packages `SEQUENTIAL_IO`, `DIRECT_IO`, and `TEXT_IO`, and describes how to use the facilities available within these packages. The RM also defines the package `IO_EXCEPTIONS`, which specifies the exceptions that can be raised by the predefined input-output packages.

In addition the RM outlines the package `LOW_LEVEL_IO`, which is concerned with low-level machine-dependent input-output, such as would possibly be used to write device drivers or access device registers. `LOW_LEVEL_IO` has not been implemented. The use of interfaced subprograms is recommended as an alternative.

#### 8.1 Correspondence between External Files and BTOS II Files

Ada input-output is defined in terms of external files. Data is read from and written to external files. Each external file is implemented as a standard BTOS II file, including the use of `STANDARD_INPUT` and `STANDARD_OUTPUT`.

The name of an external file can be either

- the null string
- a BTOS II filename

If the name is a null string, the associated external file is a temporary file and will cease to exist when the program is terminated. The file will be placed in the current directory and its name will be chosen by BTOS II.

If the name is a filename, the filename will be interpreted according to standard BTOS II conventions (that is, relative to the current directory). The exception `NAME_ERROR` is raised if the filename has more than 50 characters.

If an existing BTOS II file is specified to the `CREATE` procedure, the contents of the file will be deleted before writing to the file.

If a non-existing directory is specified in a file path name to CREATE, the directory will not be created, and the exception NAME\_ERROR is raised.

## 8.2 Error Handling

BTOS II errors are translated into Ada exceptions, as defined in the RM by package IO\_EXCEPTIONS. In particular, DEVICE\_ERROR is raised in cases of .i.Drive not ready;.i.Errors:drive not ready;drive not ready, .i.Unknown media;.i.Errors:unknown media;unknown media, .i.Disk full;.i.Errors:disk full;disk full or .i.Hardware errors;.i.Errors:hardware;hardware errors on the disk (such as read or write fault).

## 8.3 Sequential Files

For sequential access the file is viewed as a sequence of values that are transferred in the order of their appearance (as produced by the program or run-time environment). This is sometimes called a *stream* file in other operating systems. Each object in a sequential file has the same binary representation as the Ada object in the executable program.

## 8.4 Direct Files

For direct access the file is viewed as a set of elements occupying consecutive positions in a linear order. The position of an element in a direct file is specified by its index, which is an integer of subtype POSITIVE\_COUNT.

DIRECT\_IO only allows input-output for constrained types. If DIRECT\_IO is instantiated for an unconstrained type, all calls to CREATE or OPEN will raise USE\_ERROR. Each object in a direct file will have the same binary representation as the Ada object in the executable program. All elements within the file will have the same length.

## 8.5 Text Files

Text files are used for the input and output of information in ASCII character form. Each text file is a sequence of characters grouped into lines, and lines are grouped into a sequence of pages.

All text file column numbers, line numbers, and page numbers are values of the subtype POSITIVE\_COUNT.

Note that due to the definitions of line terminator, page terminator, and file terminator in the RM, and the method used to mark the end of file under BTOS II, some ASCII files do not represent well-formed TEXT\_IO files.

A text file is buffered by the *Runtime Executive* unless

- it names a device (for example, [VID]).
- it is STANDARD\_INPUT or STANDARD\_OUTPUT and has not been redirected.

If not redirected, prompts written to STANDARD\_OUTPUT with the procedure PUT will appear before (or when) a GET (or GET\_LINE) occurs.

The functions END\_OF\_PAGE and END\_OF\_FILE always return FALSE when the file is a device and STANDARD\_INPUT when it is not redirected. Programs which would like to check for end of file when the file may be a device should handle the exception END\_ERROR instead, as in the following example:

#### *Example*

```
begin
  loop
    -- Display the prompt:
    TEXT_IO.PUT ("--> ");
    -- Read the next line:
    TEXT_IO.GET_LINE (COMMAND, LAST);
    -- Now do something with COMMAND (1 .. LAST)
  end loop;
exception
  when TEXT_IO.END_ERROR =>
    null;
end;
```

END\_ERROR is raised for STANDARD\_INPUT when F6 (ASCII.SUB) is entered at the keyboard.

## 8.6 Access Protection of External Files

All BTOS II access protections exist when using files under BTOS II. If a file is open for read only access by one process it can not be opened by another process for read/write access.

## 8.7 The Need to Close a File Explicitly

The *Runtime Executive* will flush all buffers and close all open files when the program is terminated, either normally or through some exception.

However, the RM does not define what happens when a program terminates without closing all the opened files. Thus a program which depends on this feature of the *Runtime Executive* might have problems when ported to another system.

## 8.8 Limitation on the Procedure RESET

An internal file opened for input cannot be RESET for output. However, an internal file opened for output can be RESET for input, and can subsequently be RESET back to output.

## 8.9 Sharing of External Files and Tasking Issues

Several internal files can be associated with the same external file only if all the internal files are opened with mode IN\_MODE. However, if a file is opened with mode OUT\_MODE and then changed to IN\_MODE with the RESET procedure, it cannot be shared.

Care should be taken when performing multiple input-output operations on an external file during tasking because the order of calls to the I/O primitives is unpredictable. For example, two strings output by TEXT\_IO.PUT\_LINE in two different tasks may appear in the output file with interleaved characters. Synchronization of I/O in cases such as this is the user's responsibility.

The TEXT\_IO files STANDARD\_INPUT and STANDARD\_OUTPUT are shared by all tasks of an Ada program.

If TEXT\_IO.STANDARD\_INPUT is not redirected, it will not block a program on input. All tasks not waiting for input will continue running.



## Section 9

### Characteristics of Numeric Types

#### 9.1 Integer Types

The ranges of values for integer types declared in package STANDARD are as follows:

|               |                           |                   |
|---------------|---------------------------|-------------------|
| SHORT_INTEGER | -128 .. 127               | -- $2^{**7} - 1$  |
| INTEGER       | -32768 .. 32767           | -- $2^{**15} - 1$ |
| LONG_INTEGER  | -2147483648 .. 2147483647 | -- $2^{**31} - 1$ |

For the packages DIRECT\_IO and TEXT\_IO, the range of values for types COUNT and POSITIVE\_COUNT are as follows:

|                |                 |                   |
|----------------|-----------------|-------------------|
| COUNT          | 0 .. 2147483647 | -- $2^{**31} - 1$ |
| POSITIVE_COUNT | 1 .. 2147483647 | -- $2^{**31} - 1$ |

For the package TEXT\_IO, the range of values for the type FIELD is as follows:

|       |          |                  |
|-------|----------|------------------|
| FIELD | 0 .. 255 | -- $2^{**8} - 1$ |
|-------|----------|------------------|

#### 9.2 Floating Point Type Attributes

|          | SHORT_FLOAT<br>and FLOAT | LONG_FLOAT |
|----------|--------------------------|------------|
| DIGITS   | 6                        | 15         |
| MANTISSA | 21                       | 51         |
| EMAX     | 84                       | 204        |

|                  |              |               |
|------------------|--------------|---------------|
| EPSILON          | 9.53674E-07  | 8.88178E-16   |
| LARGE            | 1.93428E+25  | 2.57110E+61   |
| SAFE_EMAX        | 125          | 1021          |
| SAFE_SMALL       | 1.17549E-38  | 2.22507E-308  |
| SAFE_LARGE       | 4.25353E+37  | 2.24712E+307  |
| FIRST            | -3.40282E+38 | -1.79769E+308 |
| LAST             | 3.40282E+38  | 1.79769E+308  |
| MACHINE_RADIX    | 2            | 2             |
| MACHINE_EMAX     | 128          | 1024          |
| MACHINE_EMIN     | -125         | -1021         |
| MACHINE_ROUNDS   | true         | true          |
| MACHINE_OVERFLOW | false        | false         |
| SIZE             | 32           | 64            |

### 9.3 Attributes of Type DURATION

|                |                       |
|----------------|-----------------------|
| DURATION'DELTA | 2.0 ** (-14)          |
| DURATION'SMALL | 2.0 ** (-14)          |
| DURATION'FIRST | -131_072.0            |
| DURATION'LAST  | 131_072.0             |
| DURATION'LARGE | same as DURATION'LAST |

## Section 10

### Other Implementation-Dependent Characteristics

#### 10.1 Characteristics of the Heap

All objects created by allocators go into the heap. Also, portions of the *Runtime Executive* representation of task objects, including the task stacks, are allocated in the heap.

UNCHECKED\_DEALLOCATION is implemented for all Ada access objects except access objects to tasks. Use of UNCHECKED\_DEALLOCATION on a task object will lead to unpredictable results.

All objects whose visibility is linked to a subprogram, task body, or block have their storage reclaimed at exit, whether the exit is normal or due to an exception. Effectively pragma CONTROLLED is automatically applied to all access types. Moreover, all compiler temporaries on the heap (generated by such operations as function calls returning unconstrained arrays, or many concatenations) allocated in a scope are deallocated upon leaving the scope.

Note that the programmer may force heap reclamation of temporaries associated with any statements by enclosing the statement in a begin .. end block. This is especially useful when complex concatenations or other heap-intensive operations are performed in loops, and can reduce or eliminate STORAGE\_ERRORS that might otherwise occur.

The maximum size of the heap is limited only by available memory. This includes the amount of physical memory (RAM) and the amount of virtual memory (hard disk swap space).

#### 10.2 Characteristics of Tasks

The default task stack size is 1K bytes (32K bytes for the environment task), but by using the Binder option STACK.TASK the size for all task stacks in a program may be set to a size from 1K bytes to 64K bytes.

Normal priority rules are followed for preemption, where PRIORITY values are in the range 1 .. 10. A task with *undefined* priority (no pragma PRIORITY) is considered to be lower than priority 1.

The maximum number of active tasks is restricted only by memory usage.

The accepter of a rendezvous executes the accept body code in its own stack. Rendezvous with an empty accept body (for synchronization) does not cause a context switch.

The main program waits for completion of all tasks dependent upon library packages before terminating.

Abnormal completion of an aborted task takes place immediately, except when the abnormal task is the caller of an entry that is engaged in a rendezvous, or if it is in the process of activating some tasks. Any such task becomes abnormally completed as soon as the state in question is exited.

The message

GLOBAL BLOCKING SITUATION DETECTED

is printed to STANDARD\_OUTPUT when the *Runtime Executive* detects that no further progress is possible for any task in the program. The execution of the program is then abandoned.

### 10.3 Definition of a Main Subprogram

A library unit can be used as a main subprogram if and only if it is a procedure that is not generic and that has no formal parameters.

### 10.4 Ordering of Compilation Units

The Alsys Ada Software Development Environment for BTOS II imposes no additional ordering constraints on compilations beyond those required by the language.

## Section 11

### Limitations

#### 11.1 Compiler Limitations

- The maximum identifier length is 255 characters.
- The maximum line length is 255 characters.
- The maximum number of unique identifiers per compilation unit is 2500.
- The maximum number of compilation units in a library is 1000.
- The maximum number of Ada libraries in a family is 15.

#### 11.2 Hardware Related Limitations

- The maximum amount of data in the heap is limited only by available memory.
- If an unconstrained record type can exceed 4096 bytes, the type is not permitted (unless constrained) as the element type in the definition of an array or record type.
- The maximum size of the generated code for a single compilation unit is 65535 bytes.
- The maximum size of a single array or record object is 65522 bytes. An object bigger than 4096 bytes will be indirectly allocated. Refer to ALLOCATION parameter in the COMPILE command. (Section 4.2 of the *User's Guide*.)
- The maximum size of a single stack frame is 32766 bytes, including the data for inner package subunits unnested to the parent frame.
- The maximum amount of data in the global data area is 65535 bytes, including compiler generated data that goes into the GDA (about 8 bytes per compilation unit plus 4 bytes per externally visible subprogram).



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